ELECTRICAL ENGINEERING

FEBRUARY 1961
Vol. 80, No. 2

THE COVER: Two men replace an insulator and armor rod with bare hands on an energized conductor in normal service, and carrying its usual load. This method was developed by the American Electric Power Service Corporation and the Ohio Power Company, with the co-operation of the Holan Division of The Ohio Brass Company. Following tests in The Ohio Brass laboratory at Barberton, an aerial lift truck equipped with a Fiberglas-insulated boom and specially devised shielding was used to perform scheduled maintenance work on the 34-kv North Baltimore-Portage line of the Ohio Power Company near Bowling Green, Ohio. For this demonstration, an insulator and armor rod were replaced by the two men without other assistance or use of protective barriers. No one was on the pole. After necessary precautions were taken, the insulator was removed from the arm; then conductor, insulator, and workmen were backed away from the pole. The major part of the work was performed beyond reach of the pole or other energized conductors, and with conventional hand tools. Story on p. 164.

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Published monthly by American Institute of Electrical Engineers

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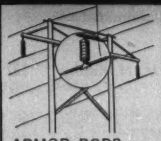
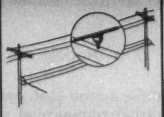
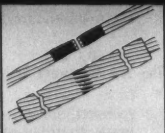


ARMOR RODS
. . . Protect long spans at supports



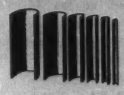
LINEGUARDS
. . . Protect short spans at supports

FANNGRIPS
. . . For dead-ending strands or conductors



FANNSPLICES
. . . For joining or patching strands

TREEGUARDS
. . . Protect conductor surface covering



KOVER-GARDS
. . . Protect surface-mounted conductors

*A superior forming method in accordance with Patents No. 2,769,478 and 2,588,663—other patents applied for.

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Statements and opinions given in articles appearing in *ELECTRICAL ENGINEERING* are expressions of contributors for which the Institute assumes no responsibility. Correspondence is invited on controversial matters. Published monthly by the

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Founded 1884

Headquarters, 10th floor • Editorial Offices 6th floor

33 West 39th Street, New York 18, N. Y.

C. H. LINDER, President — N. S. HIBSHMAN, Secretary

PUBLICATIONS DEPT., W. F. Denkhaus, *Chairman*; H. N. Muller, Jr., *Vice-Chairman*; C. S. Rich, *Secretary*; D. T. Braymer, T. H. Cline, Charles Concordia, Burke Frick, L. R. Gaty, R. B. Gear, Lenine Gonsalves, E. T. B. Gross, W. R. Harris, D. L. Hemmenway, A. W. Kessler, C. W. Leihy, L. F. Lewis, M. S. Merritt, F. W. Norris, F. C. Roberts, J. D. Tebo, J. J. Tesar, P. G. Wallace, B. James Wilson.

ELECTRICAL ENGINEERING. Published monthly by the American Institute of Electrical Engineers publication office Hildreth Press, Bristol, Conn. Editorial and advertising office, 33 West 39th Street, New York 18, N.Y. Member subscription $6 per year nondeductible from dues; single copy 75 cents. Nonmembers subscription $12 per year plus extra postage to all countries to which second-class postage rate does not apply; single copy $1.50. Entered as second-class matter at the Post Office, Bristol, Conn., under the Act of March 3, 1879. Accepted for mailing at special postage rates provided for in Section 538, P. L. & R. Act of February 28, 1925. February 1961. Vol. 80, No. 2. Number of copies this issue, 68,000.

ASCO Engine Starting Controls offer...

extra protection for your standby power equipment!

ASCO Engine Starting Controls provide fully automatic starting and stopping of diesel or gas engine driven generating sets. They offer the extra protection of a unique disconnect relay which positively prevents recranking while engine is running at full speed... helps eliminate danger of damage to starting gears. And control operation is fast... only 1/30th of a second!

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Controls designed to respond at 50% of normal battery voltage.	Assures starting even after high cranking current reduces battery voltage.
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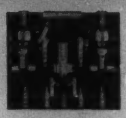
AUTOMATIC TRANSFER SWITCHES • SOLENOID VALVES • ELECTROMAGNETIC CONTROL

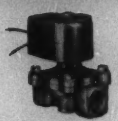
For additional information write for Catalog 50-K.

OTHER ASCO CONTROL SYSTEM COMPONENTS:

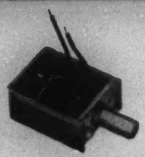
Automatic Transfer Switches *for all classes of load to 750 volts AC-DC. Transfer connected load to standby power when failure or substantial reduction occurs. Return load automatically when full power is restored—in sizes from 10 to 1200 amps. Write for Catalog 57-S1.*



Load Demand Controls *automatically start engine when load is applied; stop it when load is removed. Write for Catalog 57-S6.*



Solenoid Valves *for air starting applications, and for controlling the flow of cooling water, fuel oil and other liquids and gases. Write for Catalog 25.*



Solenoids *for fuel control devices, operating shutters for engine cooling, and other electric plant applications. Write for Catalog 57-S5.*

Battery Chargers *for heavy duty industrial use keep engine generator cranking batteries fully charged. Charger can be combined with automatic transfer panel for compact, single package arrangements. Write for Catalog 57-S6.*

Photo courtesy of San Francisco Chamber of Commerce

Golden Gateway

Beautiful, cultural, cosmopolitan San Francisco is the center of the West Coast mining area, processor of California's fabulous fruit and farm crops, and one of the nation's major distribution points and financial areas. Its importance as a western rail terminal has grown ever since the final spike was driven in the first transcontinental line, and four Class I railroads now serve the city. One of the country's outstanding electric utilities has stimulated growth by serving expanding power needs.

Kerite has anticipated and met the constantly increasing demand for electric cable, with a standard of dependability which began in 1854. *And as the need for quality cable continues to grow, Kerite will be ready to supply it.*

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New and Improved Products . . .

Hot-Box Detector Cable . . .

A 6-conductor ½-inch cable designed solely for remotely controlled railroad hot-box detection systems, incorporates features that will lower installation and maintenance costs normally associated with telephone or line wire construction. Capable of being installed on existing poles using standard grips, the cable has a built-in messenger of extra-high-strength copper-covered steel, making it self-supporting under the heaviest ice or snow conditions. Colored polyethylene-insulated conductors are also used. *Anaconda Wire & Cable Co., 25 Broadway, New York 4, N. Y.*

Single-Mounted Strain Gage . . .

This device eliminates the need for back-to-back mounting of strain gages. Since only one side is mounted, obvious advantages will be found where it is difficult to locate two gages exactly back-to-back or oriented in the same direction such as in pressure vessels and aircraft wings. Other useful applications will be found in areas that are inaccessible to dual mounting strain gages, or where pressure or hostile fluids make it impracticable. *The Budd Co., P. O. Box 245, Phoenixville, Pa.*

Meter-Time Switches . . .

The magnetic flotation system has been extended to combination meter-time switches with the introduction of these new instruments designated *J3M* and *J3V*. The former features a standard kw register and a single- or double-pole single-throw time switch for automatic control of off-peak circuits. The latter, designed principally for 2-rate billing as well as off-peak circuit control, has a 2-rate register that records kilowatt-hours on two separate dials and is automatically switched. *Sangamo Electric Co., Springfield, Ill.*

Reflector Disconnects . . .

This lighting fixture has 2 separable elements consisting of a die-cast aluminum hood and a reflector-socket assembly removable as a single unit for cleaning and lamp changing at floor level. The 2-piece disconnect socket is shock absorbing and self-centering. Live contacts are protected by barriers that prevent accidental short circuits when the reflector unit is attached. *Pyle-National Co., 1334 N. Kostner Ave., Chicago 51, Ill.*

Barometric Timer . . .

This recently developed barometric timer is a mechanical clockwork mechanism that provides a fixed time-delay between the time an arming pin is pulled and a pressure cartridge fired. It is applicable to pilot escape systems, high-speed air cargo drops, and missile arming or recovery systems. The device, which is only 4 inches long and weighs slightly over ½ pound, has an internal aneroid block that senses altitude and prevents operation beyond a preset altitude. *Patterson Moos Research Div., 90-28 Van Wyck Expressway, Jamaica 18, N. Y.*

Aluminum Switch Bases . . .

Weight reductions of 70% with high resistance to corrosion make these maintenance-free electric air-break switches less expensive to fabricate than those made of steel. Now being incorporated in the I-T-E standard 115-kv air-break switch line, development is in progress to provide a complete series of bases for all outdoor disconnect switches from 7.5 to 340 kv. Having a box design of extruded welded aluminum lengths, the resulting unit is said to have superior base rigidity and allow installation of switches with a greater overhang at the point of attachment. *Reynolds Metals Co., Richmond 18, Va.*

Lightweight Tracking Antenna . . .

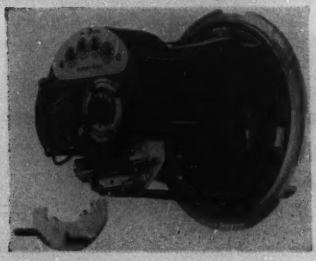
Using the Bogner modular concept, complex antenna systems of varying sizes and capabilities may be constructed by merely changing or rearranging standardized elements. This new lightweight, low-cost, air transportable, and dual polarized vhf tracking–telemetry antenna, designated *420 A*, operates in the standard frequency range of 215 to 260 mc with a gain of 18 db minimum over the band. Additional features include unambiguous acquisition mode, simultaneous 2000-mc tracking, and 125-mph wind operation and balance without the use of counterweight. *Avien, Inc., 58-15 Northern Blvd., Woodside 77, N. Y.*

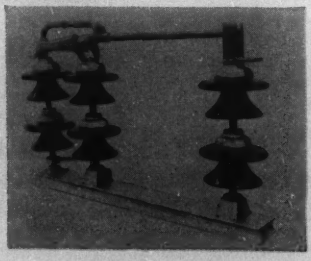
Miniature Phone Plugs . . .

These ultra-miniaturized phone plugs, engineered with the same qualities demanded of larger plugs, yet only 1/25 their size, will find applications in transistor radios, computing devices, and various types of miniature electric equipment. Available with straight black or anodized aluminum shielded handle, the tip and sleeve are made of bright nickel-plated machined brass, and the insulating sleeve of molded nylon. *Switchcraft, Inc., 5555 N. Elston Ave., Chicago 30, Ill.*

Dual Unit Circuit Breaker . . .

A new type *QO* tandem circuit breaker combines 2 full-size breakers in a single space-saving unit. Featuring ambient temperature compensation, trip indication, and full-size handles, the breaker employs thermal-magnetic construction to give full flash protection. The magnetic element opens on first flash while the thermal element holds on overloads. The *QO* tandem breakers employ new push-in connectors for faster wiring that will hold on 5,000-ampere shorts. *Square D Co., Mercer Rd., Lexington, Ky.*





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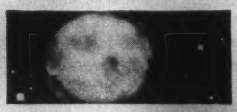
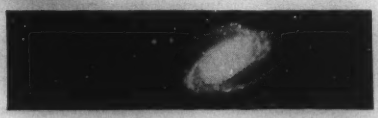
WE'RE REACHING INTO SPACE



Bell Laboratories research with chilled ruby amplifiers speeds the day we may telephone via satellites



A strange combination of Nature's forces at Bell Laboratories foreshadows the day when world-wide phone calls may be relayed via man-made satellites orbiting the earth. It is a union of synthetic rubies and extreme cold, making it possible to amplify microwave signals from these satellites clearly.

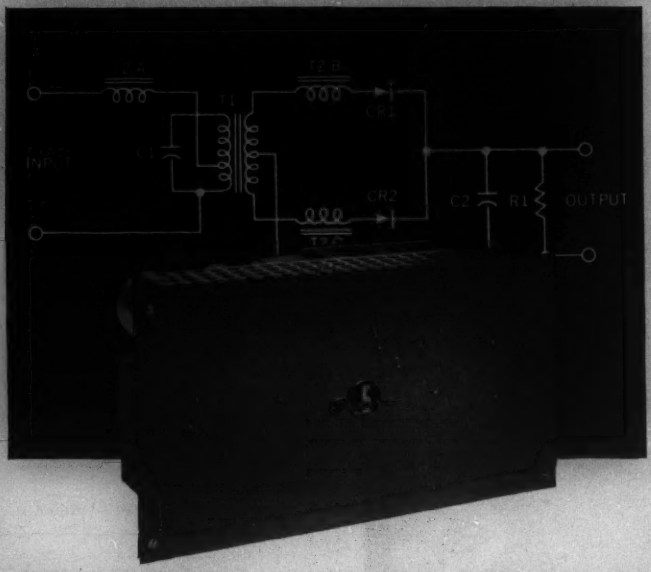
Synthetic rubies possess an extraordinary property when deeply chilled and subjected to a magnetic field. They can be excited to store energy at the frequencies of microwave signals. As a signal passes through an excited ruby, it releases this energy and is thus amplified a thousandfold.

Bell Laboratories scientists chose a ruby amplifier because it's uniquely free of "noises" that interfere with radio signals. For example, it doesn't have the hot cathodes or hurtling electrons that generate noise in conventional amplifiers. It is so quiet that only the noise made by matter itself in heat vibrations remains. But at a temperature close to absolute zero, this also is silenced. Even very faint signals from satellites can be clearly amplified and studied for their possibilities.

Bell Laboratories scientists were first to discover that matter itself generates electrical noise. They also discovered that stars send radio waves, and thus helped found radio astronomy. It is particularly fitting that the same scientists, in their endless research on noise, should now battle this number-one enemy of telephony in the dramatic new field of communication via satellites. The ultimate goal, as always, is the improvement of your Bell System communications services.

BELL TELEPHONE LABORATORIES

WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT



MD simplicity means savings for you

Here's a line of d-c power supplies you can literally mount in your relay rack and forget . . . the ultimate in simplicity and reliability. It's Sorensen's MD series featuring rugged magnetic regulation, heavy-duty silicon rectifiers, conservative continuous-duty ratings for all components. Output voltage holds to ±1% for input variations from 100 to 130 vac. 132 stock models from 3 to 1000 vdc output, 50 to 3000 watts (see table for just a few typical ratings). Several units may be used with paralleled outputs for increased capacity up to 9000 watts. Current limiting characteristics particularly suit MD's for battery charging and filament powering . . . can't be damaged by output shorts.

Write for complete MD data . . . Or, better, send for the new Sorensen catalog, listing over 400 power equipment models, plus the name of your Sorensen representative. Sorensen & Company, Richards Ave., South Norwalk, Conn.

POPULAR MODELS AND PRICES

(Numbers preceding dash in model designation indicate output voltage; those following dash indicate maximum current.)

Model	Price	Model	Price	Model	Price
50 watt		200 watt		750 watt	
MD 6.3—8.0	$159	MD 6.3—31.8	$257	MD 6.3—120	$523
MD 12—4.2	145	MD 12—16.7	215	MD 12—62.5	423
MD 28—1.8	137	MD 28—7.2	184	MD 28—26.8	336
MD 48—1.1	131	MD 48—4.2	179	MD 48—15.7	315
100 watt		400 watt		1500 watt	
MD 6.3—15.9	$194	MD 6.3—63.5	$348	MD 6.3—239	$921
MD 12—8.4	171	MD 12—33.3	292	MD 12—125	735
MD 28—3.6	158	MD 28—14.3	247	MD 28—53.6	567
MD 48—2.1	152	MD 48—8.4	231	MD 48—31.3	525

0.33

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CONTROLLED POWER PRODUCTS

. . . THE WIDEST LINE MEANS THE WISEST CHOICE

New & Improved Products

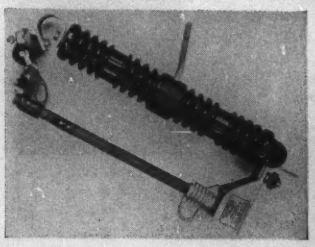
(Continued from page 8A)

Impact Molding Compound . . .

A new flame-retardant Fiberglass reinforced polyester molding compound called Grade *1506* possesses high-impact strength and good moldability in deep draw parts. The product features dimentional stability, low water absorption, and excellent arc resistance characteristics. Typical applications include switchgear bushings and supporting structures, standoff insulators, and other electric apparatus requiring flame retardant insulation. *The Glastic Corp., 4321 Glenridge Rd., Cleveland 21, Ohio.*

Fuse Cutout . . .

Two new *27KV* open drop-out cutouts have been added to the Faultmaster line. These new units feature the same single-vent, small-bore design found in other cutouts in the line. Each has a continuous current rating



of 100 amperes, the *2580* has an interrupting capacity of 3,000 amperes, and the *2581*, 6,000 amperes. Safety is assured because the single confined cone of gases is directed downward and away from personnel and equipment. *Hubbard & Co., 200 S. Michigan Ave., Chicago 4, Ill.*

Motor Starters/Contactors . . .

Designed for nonreversing, full-voltage starting of 1/6- to 2-hp squirrel cage motors, these starters and contactors may be used on either single-phase or 3-phase motors operating on 110- to 600-volt power, and 25- to 60-cycle frequencies. The starters are equipped with melting-alloy thermal-overload relays, and are available in open type or in NEMA (National Electrical Manufacturers Association) type 1 enclosures. *The Clark Controller Co., 1146 E. 152nd St., Cleveland 10, Ohio.*

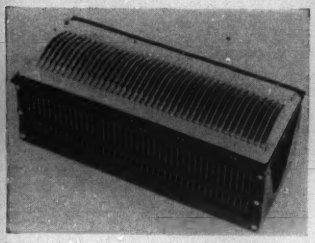
(Continued on page 19A)

New & Improved Products

(Continued from page 12A)

Data Switch . . .

Through the use of printed circuits and modular-type construction, this compact high-capacity data switch was developed for multicontact temporary or permanent switching. The model shown here contains 40 single-pole switches, each one capable of being manually positioned to select one of 56 teletypewriter character contacts positioned on glass-fiber-laminated, printed-circuit boards. Rapid setting by means of knurled edges and high

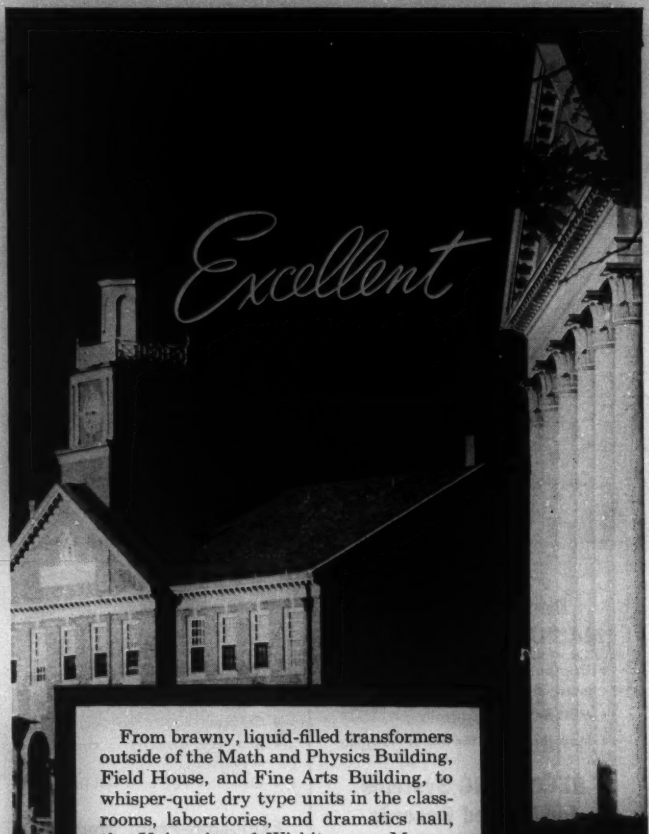


visibility of the markings allows messages or programs to be set up quickly for processing. Positive detents are provided, and output taken from a printed multicontact circuit at the rear can be provided with auxiliaries to convert to other codes as required. *Instrument Systems Corp., College Point 56, L. I., N. Y.*

Data Transmitters . . .

The Dial-o-verter, operating in conjunction with the Bell System's Data-Phone *200* subset, permits rapid transmission of punched card, punched tape, or magnetic taped data over ordinary telephone lines. Sending up to 27,000 alphanumeric characters during a 3-minute toll call period, the system has extensive error-checking facilities. All transmitted data carries both transverse and longitudinal parity checks. A message counter at the receiver corrects all messages received, automatically printing the number of any message found to contain an error, as well as printing the total number of messages in each transmission. Where the transmitting terminal contains a memory, provision can be made for the receiver to call automatically for retransmission of any message containing an error. *Digitronics Corp., Albertson, L.I., N.Y.*

(Continued on page 20A)



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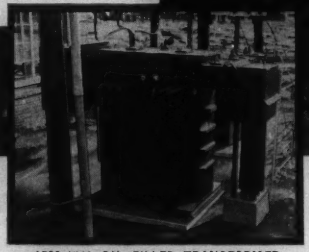

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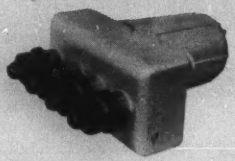

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New & Improved Products

(Continued from page 19A)

Adjustable Switch . . .

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Mercury Relay . . .

Silent and chatterless, this new plunger-type mercury relay is particularly suitable for heavy loads similar to those experienced in resistance heating equipment, drying apparatus, heat treating furnaces, welding operations, and illuminated signs. Containing only one moving part, the relay will provide millions of operations with make-break speeds of up to 100 per minute at rated loads. Contact rating for general a-c applications ranges from 120 volts, 30 amperes to 440 volts, 8 amperes and noninductive a-c heater loads range from 120 volts, 35 amperes to 240 volts, 25 amperes. *The Mercoid Corp., 4201 Belmont Ave., Chicago 41, Ill.*

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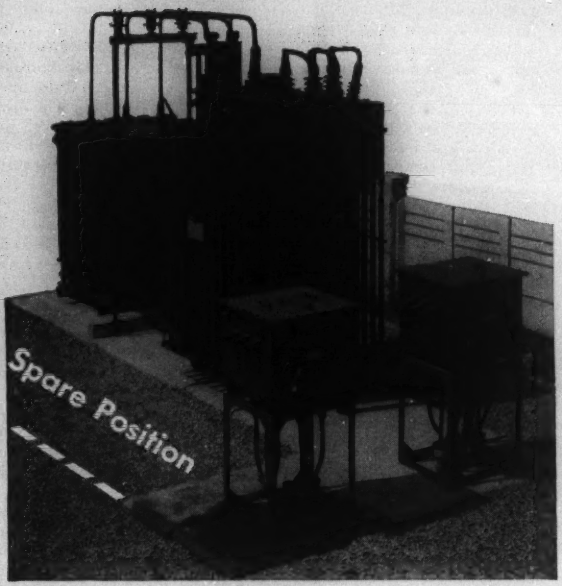
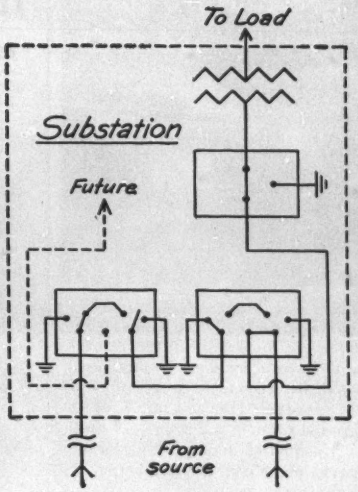
(Continued on page 22A)

Gain System Flexibility, Continuity, and Economy with G&W Type RAL Load-Break Oil Switches





Flexibility and continuity in system operation are gained by looping feeds to substations or loads. Economy, reliability, and simplicity are provided and flexibility increased when pre-engineered, standardized G&W Type RAL Load-Break Oil Switches are used to switch these loops.

Standardized Type RAL switches are engineered and built expressly for loop-through and tap circuits such as shown here. Any section of the loop can be isolated or any load or main tapped off the loop can be bypassed without affecting service to remainder of loop.

The standardized Type RAL switch is a three-way unit with tie buses for by-passing. Two lever-operated load-break Rocker Arm Links provide for looping through with or without the load connected. Optional ground positions for each of the Rocker Arm Links permit simple and positive grounding of selected cable sections.

G&W Type RAL switches are standardized which means faster and more dependable delivery as a result of assembly from factory component stock. Standardized Type RAL switches are based on components of proven performance for long, reliable service, economy, and effective operation.

Standardized G&W Type RAL switches are available in two voltage ratings, 7.5 or 15 kv. Switches will carry and interrupt full 400-ampere load. BIL and 60-cycle test voltages are equal or higher than AIEE, EEI, & NEMA.

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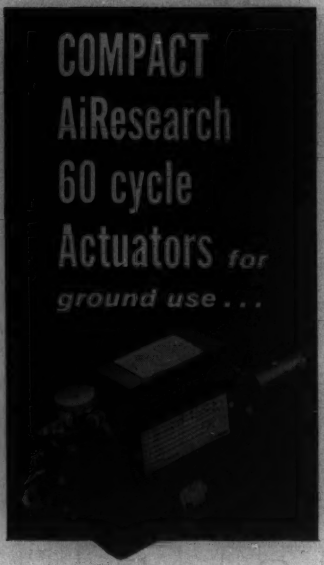

Inexpensive, lightweight 60 cycle motor driven actuators with integral magnetic brakes* are now being manufactured by AiResearch for ground radar, ground support and shipboard use.

Unequalled in 60 cycle performance, these extremely compact, lightweight actuators range from fractional hp motor size up to any desired hp in single phase, two phase and three phase design for a wide variety of applications.

The above-pictured actuator is used in a ground radar system. It is driven by a single phase 60 cycle ac fractional hp electric motor and can be furnished with a feedback potentiometer for use in servo applications. The entire unit weighs only 2½ lb. and is rated at 200 lb. operating load.

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New & Improved Products

(Continued from page 20A)

Constant Light Source . . .

A new d-c power auxiliary for operating 150-watt *XBO* xenon arc lamps assures continuous stabilization by regulating the light output within ±1% for line voltage variations as great as ±12%. Consisting of a constant wattage transformer and step-down transformers, full-wave rectifier, capacity filter and relays, the unit permits exacting experimental and testing work where quantitative light measurements must be made and compared. *Sola Electric Co., Elk Grove, Ill.*

Radiography Cameras . . .

This inexpensive line of iridium *192* Radionic cameras was designed for panoramic and internal radiography. Useful in radiographing ¼ inch to over 3 inches of steel or ¾ inch to 9 inches of aluminum, iridium *192* provides as much as 100 curies of radiation with a focal spot diameter of only 0.125 inch. All five of the *192* series cameras are portable and require no external source of power or cooling. *Radionics Inc., Lafayette & Water Sts., Norristown, Pa.*

Oscilloscope Camera . . .

The *C12* accepts Polaroid or any conventional film for undistorted viewing and direct recording of oscillograph traces. Utilizing a unique sliding back which is adjustable to horizontal or vertical positions and can be locked

in five detent positions, the camera uses any of eight easily interchangeable lenses in varying object-to-image ratios and maximum aperture to f/1.5. Other features include one-hand portability, lift-on mounting, swing-away hinging, and comfortable viewing. *Tektronix, Inc. P. O. Box 500, Beaverton, Ore.*

Elapsed Time Meter . . .

Available with or without a reset knob, and mounted from either the front or back of the panel, this new type *BH 351* has 6 register wheels giving indication up to 99,999.9 hours. All digits are white on a black background, except the tenth digit which is black on white. The meter will be found

particularly suitable for tube replacement programs and maintenance scheduling of electric equipment, including diesel generators, motors, welders, and radio and television transmitters, since the device indicates total time a circuit is energized. *Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh 30, Pa.*

Quick-Heating Tube . . .

The *4604* beam power tube was especially developed for "push-to-talk" mobile radio transmitters where standby power is at a premium. Capable of delivering 30 watts of power in continuous wave or FM service at 175 mc, the quick-heating filament takes less than 1 second to reach operating temperature. The coated filament draws only 0.65 ampere, and was designed to operate at 6.3 volts. *Radio Corp. of America, 30 Rockefeller Plaza, New York 20, N. Y.*

Ultrasonic Welder . . .

The complete gamut of microjoining, including heatless welding and fluxless soldering, can be accomplished with one versatile unit. Consisting of an ultrasonic transducer hand piece and four basic inserts with additional tips, the kit will provide welds that were hitherto impossible or very difficult to perform. Welded gold wire as fine as 0.0004 inch in diameter, soldered gold wire on gold plated silicon, or 0.003-inch aluminum foil are some examples of joining operations that can be performed with this kit. *Cavitron Corp., Long Island City, N. Y.*

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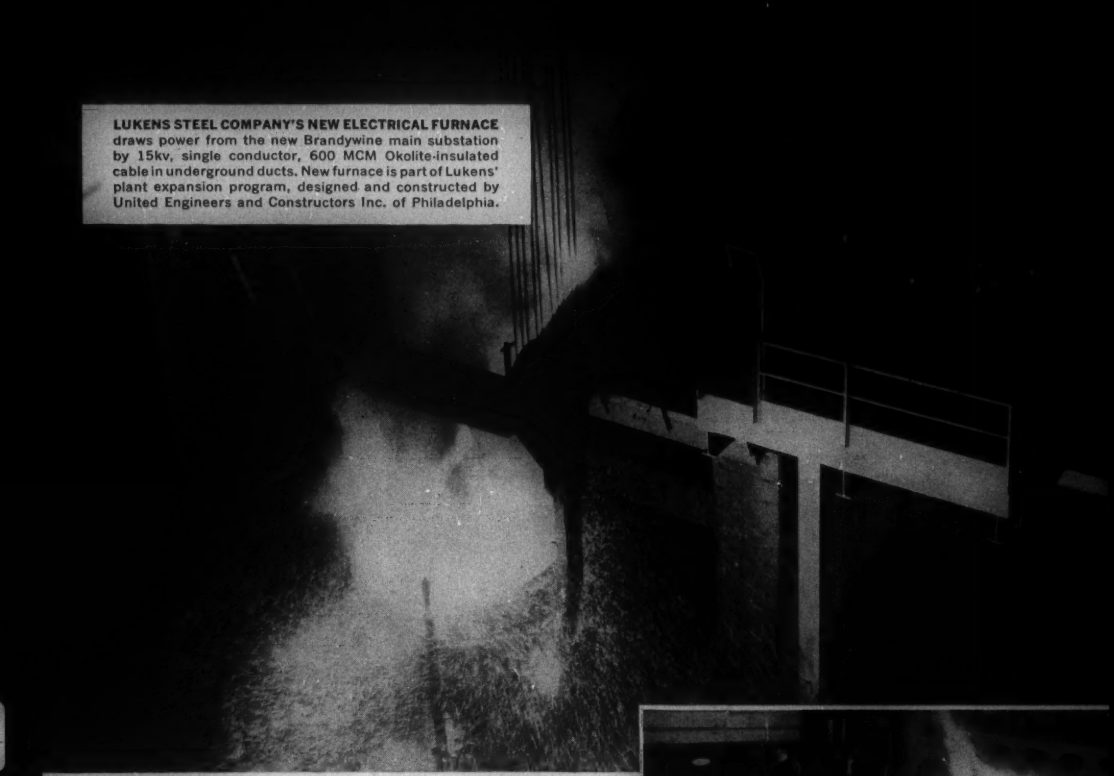

LUKENS STEEL COMPANY'S NEW ELECTRICAL FURNACE draws power from the new Brandywine main substation by 15kv, single conductor, 600 MCM Okolite-insulated cable in underground ducts. New furnace is part of Lukens' plant expansion program, designed and constructed by United Engineers and Constructors Inc. of Philadelphia.

How Okonite Cable'bility* protects plant profits at Lukens Steel

Lukens Steel Company, like hundreds of leading corporations throughout the world, makes extensive use of Okonite cable for its crucial electrical circuits. They have found that long-lived, dependable Okonite cables are indispensable on important applications to maintain profitable production —an assurance based on the excellent service records of Okonite cables in their own and other plants. There are four basic reasons for these service records:

1. **Engineering experience,** derived from developing long-lived cables for every type of industrial application.
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Send for more information about Okonite insulated cables and its applications. Also available from Okonite: Bulletin 1098 "Power and Control Cables for Steel Mills."

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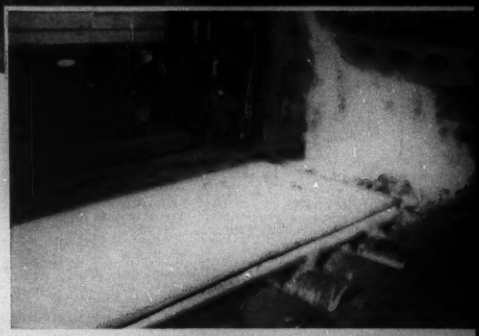

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New & Improved Products

(Continued from page 22A)

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High-Speed Motor . . .

Developed by one of Japan's leading electrical manufacturers, this 0.2-kw motor is capable of reaching speeds up to 150,000 rpm. Similar in operating principle to bi-polar 3-phase induction motors, its exceptionally high speed is made possible by the 3-phase 2,500-cycle output of a silicon-controlled static inverter. Water-cooled, and lubricated by oil injected by compressed air, the motors will be used to drive lathes and grinders with particular application to the manufacture of bearings. *Tokyo Shibaura Electric Co., Tokyo, Japan.*

X-Ray Image Intensifier . . .

This new product, first introduced for medical diagnostic work and now available for industrial applications, produces images 3,000 times brighter than those normally found on conventional fluoroscopic screens. Intensification is achieved electronically, thereby greatly reducing the amount of radiation exposure and protective shielding usually associated with this equipment. Still another advantage is that the operator can begin inspection immediately without the interval usually needed to accustom the eyes to a darkened room. *Tracerlab Industrial Div., 1601 Trapello Rd., Waltham, Mass.*

Portable Diode Tester . . .

This portable diode tester was designed to test diode matrix boards used in conjunction with 16-switch or 28-switch electronic timers. Designated model *DTM-1001,* the tester manually checks the presence and correct polarity of diodes in specified circuit positions on the matrix boards. In addition, it tests the diode forward current at 1 volt, and reverse leakage current at 25 volts. Diodes meeting forward and reverse resistance specifications and correct polarity in the proper place on the matrix board are so indicated by a green signal light on the front panel. *A. W. Haydon Co., Culver City, Calif.*

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The first practical application of a line voltage heater built into a small thermostat employs the internal heater to influence the natural response of the thermal element to ambient temperature. Designed primarily for appliance control systems, the *20450* is supplied with a single-pole single-throw arrangement in 2 contact structures. As a fan switch, the circuit closes on temperature rise; as a high limit switch, the circuit opens on temperature rise. A single-pole double-throw action is also available. *Texas Instruments Inc., 34 Forest St., Attleboro, Mass.*

Microwave Power Unit . . .

Using a compact 2-bearing construction, this new motor-generator set consists of 2 prime movers on a common yoke. Designed to give uninterrupted power for microwave repeater stations, a Synduction motor drives the generator using a commercial source of power. During power failure, a d-c motor provides standby current. Fields and brushes are energized from a 120- to 145-volt battery with the brushes removed from the commutator by mechanically linking them to solenoids connected to the same source supplying the Synduction motor. *Allis-Chalmers Mfg. Co., Milwaukee 1, Wis.*

Post Office Mechanization

B. M. LEVIN M. C. STARK P. C. TOSINI

An approach to the mechanization of letter sorting called "codesorting" is presented. This approach utilizes a computer as an integral part of the system. The operational characteristics and requirements of the computer are emphasized.

THE operations performed within an individual post office are quite straightforward. The post office receives mail in an essentially random order. The mail is sorted at the post office into categories based on the final destination of the individual pieces of mail. The mail is then either delivered to the patron, or dispatched by truck, airplane, bus and/or train to another post office from which it can be delivered to the patrons (sometimes via several other post offices, each of which also performs a sorting operation on the mail).

The sorting operation essentially does nothing more than to refine successively the order of the pieces of mail. Their "information content" increases as they flow through the post office. However, this conceptually simple series of operations does have some rather involved design and operational problems due to the large volumes that must be handled and the large number of final destinations involved.

Although mail in general is a very unstandardized item, with respect to shape, size, and weight, letters do approach a degree of standardization. Here, therefore, is a situation that strongly implies the feasibility of mechanization; namely, a repetitive operation performed on a large quantity of relatively standardized items.

THE MANUAL POST OFFICE

BEFORE DISCUSSING the automated post office it will be necessary first to present some of the major characteristics of the present manual post offices in order to isolate the parameters, affecting mechanization.

There are five distinct sequential operations comprising the mail handling activities in a post office: (1) culling; (2) facing and cancelling; (3) sorting; (4) sweeping and tying out; and (5) dispatching or delivery.

In the culling operation a rough sorting is performed. The sorting categories represent types of mail, each of which is handled in a different location in the post office; for example, letter-size air mail, letter-size first-class mail and parcel post are three of the categories. The letter-size mail is then faced, that is, the letters are arranged so that they all face the same way.

Fig. 1. The manual sorting of mail.

The letters are cancelled (postmarked) by an automatic cancelling machine and taken to the sorting area of the post office, where they are sorted into small bins. The mail is taken out of the bins, collocated with other letters going to the same destination and tied into a bundle; this is the sweeping and tying-out operation. If the bundle of letters is to be delivered by a carrier who leaves from that post office, the bundle is sent to his desk. Otherwise, the bundle is put in the proper sack which in turn is sent to the next post office.

The sorting operation is, of course, the major activity. The post office is essentially a group of people sorting mail by a set of sorting rules (called schemes) through stages of "cases" composed usually of 49 to 77 "pigeonholes" (cubical receptacles). These pigeonholes correspond to:

1. Specific final destinations (e.g., post offices, letter carriers) or groups of destinations leaving the sorting process or,

2. Inclusive sets of destinations which are further sorted in another bank of cases. Within the restriction imposed by the case size, the most active destinations appear on the primary cases, those cases at which the first sorting is performed. The remaining mail passing through the primary cases is sorted to pigeonholes representing inclusive categories; e.g., all the mail to a given state. These categories then have their own cases. In large post offices sorting to many destinations, the successive refinement of the mail may require up to four sorting stages called the primary, secondary, tertiary, and fourth stages.

Mail is first classified as local or outgoing. Local destinations are those included within the delivery area of the post office and its branches. Outgoing destinations are those delivered by other post offices. The objective is to sort local mail down to the level of the delivery unit (truck or carrier) and outgoing mail to the post office level (or to groups of post offices for those cities

A special article recommended for publication by the AIEE Computing Devices Committee.

B. M. Levin, M. C. Stark, and P. C. Tosini are with the Data Processing Systems Division, National Bureau of Standards, Washington, D. C.

Courtesy ITT

Fig. 2. "Raw" mail is culled or separated at a rate of 25,000 pieces an hour as it pours in a continuous stream onto first one, then another, and still another vibrating table. Packages and pieces of mail too large for processing are removed by conveyors for further separation.

receiving relatively little mail from the originating city).

The clerk at the local primary sorting area extracts mail for the largest destinations and sorts the remainder to zones. The zoned mail is then sorted to bins representing other large receivers and to carriers. The carrier mail is then delivered to the individual carriers who sort their mail to their walking order at their own cases. At each stage of the sorting, mail sorted to its final destination on any case must be swept from the bins and grouped with the identically destined mail from duplications of those cases. Mail sorted to categories requiring further sorting must be swept, grouped, and delivered to the stage performing that sorting.

Outgoing mail is treated much the same way. All mail entering a post office is first sent to the outgoing primary stage. There local mail is separated and shunted to the local primary. The outgoing destinations meriting their own pigeonholes are sorted and the remaining outgoing mail is sorted to state residues, "catch all" bins that receive mail for all small post offices in a state or group of states. This residue mail is then further sorted to directs and residues on these cases. For example, at the Washington, D. C., post office a letter addressed to Baltimore, Md., or New York City leaves the sorting process at the outgoing primary. But a letter destined for Palm Springs, Calif., is sorted to a "California Residue" box in the primary sorting area since Palm Springs does not receive enough mail from Washington, D. C., to merit its own bin in the primary area. At the California residue case (a secondary), Palm Springs again does not have its own pigeonhole so the letter is sorted to a box labeled "California M-P" which receives mail for all small post offices in California having as a first letter of its name M, N, O, or P. At the California M-P case there does exist a "Palm Springs" box. The letter is then sorted, bundled with other Palm Springs letters and dispatched.

The above are relatively clear-cut examples since the cities had their own bins somewhere within the sorting process. In reality, however, the burden imposed on the mail clerks is much greater than has been implied. The great majority of destinations (but not of the volume of mail) do not have unique pigeonholes. They are sorted to train lines, highway post offices or distribution centers. For example, in Washington, D. C., mail is broken down for every post office in 13 states. The mail for small post offices in these states is sorted to categories representing railway post offices, highway post offices, and post offices that are distribution centers. This implies that for each of these 13 states there must be sorting clerks who know for each small destination which post office can most efficiently process this letter next. Because of transportation schedules, the most efficient place to send a letter for its next sorting sometimes changes in a 24-hour cycle. Changes in transportation schedules also affect the sorting plan. For example, Pennsylvania has about 2,000 of these small post offices whose schemes must be memorized.

The major factors affecting post office operation can now be listed:

1. Variables over which the post office has no control: (a) volume of mail per unit time; (b) relative mail volume per destination; and (c) dispatches on most passenger trains, planes, and buses, i.e., their schedules.

2. Parameters that can be controlled by the post office: (a) dispatches on trucks; (b) number of sorting clerks; (c) average backlog of mail maintained to insure proper utilization of manpower and equipment; (d) sorting schemes including number of bins per sorting case, number of stages, etc; and (e) bin sweeping schedules.

The objective of any post office is to choose the set of parameters that best sorts the mail, given the variables over which the post office has no control. This criterion is rather fuzzy since "best" cannot be defined in terms of maximum profit. It reduces to sorting the mail as rapidly and as efficiently as possible within budgetary restrictions.

As ground rules for post office mechanization effort, it is apparent that: (1) Manual handling of letters should be drastically reduced; (2) Reliance on human memory for sorting should be greatly decreased; (3) Procedural parameters such as sweeping and dispatching schedules should be automatically controlled and easily modified; and (4) Precise volume and distribution counts of the mail should be maintained and periodically examined to determine significant changes in the system's performance and its output requirements.

Automatic equipment promises to fulfill these requirements. The following sections of this article will indicate how these four goals can be achieved in the codesort system of sorting letter-size mail.

THE CODESORT SYSTEM

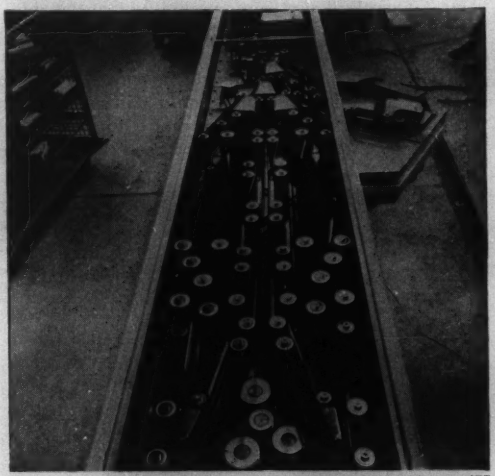
THE BASIC COMPONENT of all mechanical systems of sorting mail is the distributor or "mail sorting machine." The distributor picks up the letters with a vacuum pickup, transports them to the proper receptacles and deposits them there. There are two general types of mechanized mail sorting systems: keysort and codesort. The major difference between the two is the procedure used to give the distributor information regarding where to deposit the letters being sorted. In the keysort system, a keysort operator reads the addresses as the letter enters the distributor and depresses a set of keys indicating the proper receptacle. In the codesort system a computer is used to determine the proper receptacle. There are several different distributors that are now commercially available for the sorting of mail.

In the codesort system the input for the computer is the address in an abbreviated form. This abbreviation is put on the letter by a coding clerk. The present procedure is for the clerk to use a typewriter keyboard. A portion of the envelope is sprayed with a magnetic ink and the abbreviated address is written on that portion of the envelope in a binary coded format. As the letters enter the distributor the coded addresses are read and compared with corresponding entries within the memory component of the computer using a table look-up routine. The memory entries include the bin number information used to direct the letter to its proper receptacle. The letters are then mechanically conveyed to the bins.

The pioneering efforts in this approach to sorting mail were done by M. Levy and his associates, of Ottawa, Ont., Canada, for the Canadian Post Office.

The Coding Procedure. The coding or abbreviating procedure must meet two requirements. First of all, it must be simple enough that clerks can quickly be taught to abbreviate the addresses rapidly. Secondly, it must be amenable to a rapid table look-up by a relatively simple and inexpensive computer. Many different coding plans were considered. It was decided that the local portion of the address and the outgoing portion of the address would be coded separately as needed. The outgoing portion of the address would contain an abbreviated form of the city name followed by a 2-character abbreviation of the state name. In the case of the more frequently appearing cities, special 2-character short codes would be used. The incoming portion of the address would be put on the letter at the post office of destination. It would consist of two fields separated by a special character activated by the space bar on the keyboard. The first field would normally contain the house number. The second field would normally contain the abbreviated street name, the street type (avenue, road, etc.) and in some cities the section designation (southwest, northwest, etc.) Variations of this format would include having the first field contain the room number and the second field contain the abbreviated form of the building name for mail going to large office buildings. After extensive investigation, two procedures for abbreviating state and city names appeared to be promising. One was a relatively simple 6-character code. This code required the coding operator to type the first three characters and the last three characters in the name: in the case of names having less than six characters, the whole name was typed. The second procedure used a relatively complicated set of coding rules but the abbreviations required only four characters. The two coding procedures were taught to random groups of postal clerks who could not type and to random groups of successful applicants for typing positions. In both cases, the simpler code was learned more rapidly but after about 200 hours of practice the coding speeds were about equal. It is assumed that if the practice had been allowed to continue the shorter code would have had the faster coding rate.

The Directory. Up to this point mention has been made several times of a straightforward table look-up in the directory. Since we are dealing with alphanumeric characters it is possible to store the destination names in an alphabetic order. Since the maximum length code is known, any computer with a very large random access memory could probably be used to perform the table look-up. However, in a city the size of Washington, D. C., more than 200,000 separate addresses would need to be stored for the local portion of the address. This is indeed a large memory requirement. Fortunately, procedures can be and have been developed which greatly diminish the memory requirement. The first set of such procedures was developed by Arthur Holt of the Rabinow Engineering Company, who presented them at the 1958 Eastern Joint Computer Conference. His procedures were amenable to use



Courtesy ITT

Fig. 3. Letters and cards are placed in proper "stamp down" position by a combination of photoelectric cells and inverting belts at a rate of 25,000 an hour. The "electric eye" system also determines whether stamp is on leading or following edge, separating mail on this basis for high-speed cancelling heads.

in the construction of a special purpose computer with a single, large-drum memory which he is now building for the Post Office Department. Mr. Bernard Narrow of the Remington Rand Corporation has developed efficient procedures for using the UNIVAC file computer, model *0*. The main advantage of Holt's special purpose computer, which was also described in his paper, is that it will be able to perform more searches per unit of time than commercially available general purpose computers of comparable cost.

Discussion. The table look-up of the abbreviated addresses can be considered to be a type of data-retrieval problem. A bin location is retrieved using the abbreviated address as the input information. The computer can also be considered to be a control computer in that it does direct the sorting process performed by the distributor; i.e., it directs the letters to the proper bins. Because of the control functions of the computer, the data-retrieval aspect must be performed in a short period of time, even for the most difficult retrieval problem. Buffer storage can be used to allow some look-ups to take longer than the mean available time but there is a definite limit to the ability of buffer storage to handle gross execptions or many exceptions.

An interesting aspect of the data-retrieval problem is that not all addresses need to be found in the directory. We would not expect to find an address that does not exist; for example, a letter destined for Atlantic City, N. J., addressed to Atlantic Beach, N. J., should not find a match in the memory because there is no Atlantic Beach, N. J. All such letters for a given state or an alphabetic subdivision within a state will be sent to a separate bin without the code's being specified in the memory and the letters will then be given a hand sorting by an experienced postal clerk called the "Nixie Man." There will also be the possibility that the abbreviated city name will have the same abbreviation as another city. In such a case we would have an ambiguous code. Ambiguous codes might be omitted from the directory in which case they would fall into the bin described above. They could however fall into a special bin designed to collect mail for several ambiguous codes. Such letters could then be sorted to the proper city with a single manual sorting. The system can, therefore, manually handle improper addresses and ambiguous codes.

Courtesy ITT

Fig. 4. Each of the six operators of the letter sorter machine directs an average of 50 letters a minute to any of 300 destinations—an hourly total of 18,000 pieces of mail for each machine.

We can cut down the relatively small number of letters receiving ambiguous codes by assigning special codes to those cities that have ambiguous abbreviated addresses and that also receive large amounts of mail. We could cut down the number of letters failing to find a match in the memory by including in the memory commonly used improper addresses. For example, the letter addressed to Atlantic Beach, N. J., is more likely to be destined for Atlantic City, N. J., than for Atlantic Highlands, N. J., or for any other New Jersey destination. Therefore, the code for Atlantic Beach, N. J., could be entered in the directory with the bin number for Atlantic City, N. J. As an alternative it could be put into the machine with the bin number for Atlantic Beach, N. Y. An experienced post office employee would have to make the decision as to which was the more likely destination for the misaddressed letter and the appropriate bin number would be put in the memory.

A simpler type of problem, on the surface, is the use by patrons of suburban development names rather than proper post office names. For example, in Washington, D. C., post office records contain a listing of over 200 names that are sometimes used in place of the simple designation "Washington, D. C.," and this list is not complete. Obviously, it would be possible to put all known alternate names and many anticipated incorrect addresses in the random access memory. The post office however, has to sort mail as cheaply as possible and it is not economically justifiable to put all such addresses in the memory. For example, assume it will cost $1 per year to include an address in the memory. If that address appears only once a week, and if it costs 1¢ to handle such a letter manually, it would not be economically justifiable to put that name in the directory. The figures just quoted are for illustration purposes only.

Systems Studies. During the course of the development of the codesort systems, considerable effort was expended in determining just how the equipment could be used. This involved an extensive investigation of the present manual procedures, statistical sampling studies of mail characteristics, cost estimates and related studies.

In the previous section it became apparent that information is needed regarding the addressing habits of the mailing public. For example, if the mailing public often uses improper or alternate names for post offices it will be necessary to put such names in the directory. If the mailing public does not use these names they would not be included in the directory and a smaller memory could be used. We are now in the process of investigating this problem. Preliminary results indicate that for Washington, D. C., only 75% of the mail follows the standard format described above. For example, 7% of the mail is addressed to an intersection of two streets rather than to a building number and street. (The coding plan is able to

handle this type of exception by treating the first street as a house number.) This is only one example of the studies that are necessary to put an efficient codesort system into operation.

Probably the most important of all the studies that were performed were the cost studies. It is by no means obvious that the codesort system as described in this article will prove to be more economical than other ways of sorting the mail. In fact, the cost studies have not yet shown that a codesort system would be more economical than other proposed procedures. An interesting aspect of the cost studies is that 90% of the total cost of sorting mail in a highly mechanized post office can be attributed directly to labor costs involved in operating the equipment and in associated supervisory costs. In a codesort system the largest portion of this cost can be charged to the task of abbreviating the addresses. Therefore, the efficiency of this system depends in great part on the productivity of the coding operations. If the coding speed turns out to be as fast as we expect on the basis of some preliminary tests, codesorting will be an economically justifiable procedure.

We are planning to start tests soon to determine the coding speeds of operators using live mail. It should be noted that if the coding rate proves to be slow, this will not necessarily stop the investigation of codesort systems because it may still be possible to design a better coding procedure. There is also the possibility that patrons who send large amounts of mail on routine mailings could put the code on the letters themselves automatically as part of their addressing operations.

Early in the project it was deemed necessary to determine the volumes of mail going to various final destinations from typical large post offices. The destinations would include post offices in the case of outgoing mail, and large firms and carriers in the case of local mail. In order to accomplish this task accurately and economically, a novel statistical sampling procedure was developed by Norman Severo, then of the Applied Mathematics Division of the National Bureau of Standards. We have used this sampling procedure to study the outgoing mail characteristics of letter-sized mail in four cities; i.e., Washington, Baltimore, Los Angeles, and San Francisco, and to study the local-mail characteristics for Washington and Baltimore. The studies of outgoing mail showed that for all cities studied a majority of the mail goes to only a few destinations. For example, 40% of San Francisco's mail stays in the city. The next 20 most popular destinations account for an additional 25% of the mail. For local mail, however, only a small portion of the mail is addressed to the few largest receivers. Most of the mail—over 70%—is delivered by carriers to the individual patrons.

The few post offices that receive a majority of the outgoing letters could be assigned short codes of two characters each, which would be considerably shorter than the normally assigned 6-character codes. (Four characters for the city, two for the state.) This would have several effects; first, it would decrease the cost of the coding operation, and secondly, if letters to these destinations were sorted into a separate pile during the coding process, then these letters could be fed into the distributor using an input station connected to a simple computer with a relatively small memory. Thus, a large percentage of the outgoing mail could bypass the relatively expensive computer. These two illustrations show how basic data regarding mail can profitably be used in the design of efficient procedures. It is interesting to note that these data are not the same data that are normally collected by the post office for cost-accounting purposes.

Courtesy ITT

Fig. 5. Clerks remove letters from the destination bins at the back of the letter sorter. The letters are tied and placed on conveyors which move them to an assembly area for routing to trucks, trains and planes, or to carrier stations.

SPECULATIONS FOR THE FUTURE

In a codesort system many of the sorting clerks would not need to know the present complex manual sorting plans. (Of course, some clerks, for the near future at least, would have to use the sorting plans for mail that present codesort equipment cannot handle efficiently.) In place of the manual sorting plans, they would have to learn the coding plan. In short, their present mental functions would be done by a computer and they would have, instead, the task of preparing the input data for the computer.

A digital-clock could be incorporated into the computer to allow alternative bin numbers to be read out at different times during the day. Thus, mail too late to make the dispatch to one distribution center for resorting could be sent to another distribution center rather than wait up to 24 hours for the next dispatch. Such flexibility is now in the manual system and it often allows letters to be delivered a day earlier than would otherwise be the case.

Since every letter that is processed through the system is individually processed by the computer, mail for each destination can easily be counted as it is sorted.

The computer component of the system, therefore, provides four major features: (1) The computer has complete control of the bin assignments; (2) Modifications to the sorting plans can be readily introduced by making simple modifications in the memory infor-

mation; (3) Mail for each destination can be counted easily as it is sorted; and (4) A digital clock would allow alternative bin numbers to be read out at different times during the day or under special circumstances.

These features provide the requisite information for complete feedback control of the sorting and tying-out operations since the parameters governing these can be formulated within the computer program.

This expanded control program would then follow these steps. First, the coded address is read and, using a table look-up, is matched against the file-directory. When the appropriate memory entry is found, its bin number is read out and used to determine the bin into which the letter is to be deposited. Simultaneously, two totals are updated; first, the daily mail volume to that particular destination; and second, the volume of mail sent to the particular bin since it was last swept. The latter control total is then compared with a number representing the bin's capacity, with the time of the next dispatch and with the anticipated volume to that bin. The computer can then determine whether or not to activate a mechanism that automatically sweeps the bin and ties-out the contents. For example, if a bin that usually receives only one bin load between dispatches is "full" a few minutes before dispatch, the computer should not activate the sweeping mechanism but rather should allow a few extra letters to be added in order to prevent having a second tie-out with only one or two letters in the "bundle."

Other on-line changes are also possible. For example, if a train is running late it would be possible to delay the automatic sweeping of letters for this dispatch through the computer's controlling this operation.

The daily mail-volume figures would be used not only to check on the productivity of the system but also as basic data for deciding on changes to be made in the system. For example, the average bundle of mail to a given destination may be too small to justify special bundles being prepared for that destination. This type of datum will facilitate making the decision to sort mail to this destination so that it will go to a distribution center for further sorting. Since this can be made into a clerical task, a general-purpose computer could be used to make such decisions and to incorporate the changes in the directory.

It is believed that all of the speculations made in this section could be put into operation in a post office, using presently available computers. The main question involved is their economic justification.

CONCLUSIONS

THE MULTIPLE HANDLING of individual letters will be made unnecessary by the codesort system. A letter will receive the time-consuming individual attention of an operator only once. If the letter is not immediately sorted to its final separation, the code impressed upon it will permit later machine-sorting without any further individual processing.

An ultimate aid is public participation. To the extent that the public can be induced to add the code so that it can be read directly by a machine, even the one-time individual handling of the letter can be eliminated.

Changes in schedules affecting the sweeping of bins and the dispatching of the mail can be controlled quickly and readily at a central source by making the appropriate changes in the electronic memory.

A useful by-product of the codesort operation is the provision of a ready means of counting the mail for volume and distribution breakdowns. The tallying can be done precisely on a continuing basis to make possible changes in procedures which will improve the effectiveness of the whole system.

It is instructive to notice the evolution that is taking place in letter sorting. Originally the human operator handled the letters personally, and was limited by his physical reach and by his memory of the sorting schemes. In the semi-automatic or keysort devices, his reach is in effect extended because he can press keys causing the device to carry the letters to bins farther away (up to 300 bins). Note, however, that he still has to know to what bin the letter should go.

Finally, in the codesort system the human operator is limited by neither his reach nor his memory. He has only to remember a few coding rules; the machine does all the rest, that is, knows what to do with the letter and can transport it to the proper bin wherever that bin may be.

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Information Presentation Systems

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T. L. STODDARD

Machine-controlled presentation subsystems have been developed for the purpose of displaying information at electronic speeds. These systems transform the continuous flow of facts and data received by an organization into selected, significant information, which is then presented in capsule form to the decision maker for implementation.

VISUAL DISPLAYS are one of the primary means for communication between the human and machine components of an information system. An information system as a whole consists of several machine subsystems, each having a particular function:

1. *Communications Subsystem.* Includes radio and wire communications transmitting the information from an electronic source such as sensors, or from other men.

2. *Information Handling, Storage, and Retrieval Subsystem.* Includes automatic cameras and automatic film files. These are used for storing and retrieving large quantities of documents and photographs.

3. *Information Conversion Subsystem.* Includes such equipment as character readers, machine language translators, and card or paper tape readers. These are used for converting the information to digital form.

4. *Information Processing Subsystem.* Includes special and general-purpose computers used for storing, searching, retrieving, and manipulating information in response to a request.

5. *Information Presentation Subsystem.* Includes such equipment as printers, plotters, optical projectors, cathode-ray tubes, other special devices, and associated equipment used for displaying information to the human viewer.

Machine-controlled information presentation subsystems used for displaying information at electronic speeds are the subject of this article. Their usefulness hinges on their ability to output relevant information quickly in such a form that the viewer can take the action required in a timely manner. The over-all effectiveness of the display subsystem depends on the net effectiveness of its three complementary elements: men, machines, and methods. These are also the elements of all the information subsystems, but are discussed here in the context of displays. These elements are interdependent, and their arrangement in a proper relationship involves balancing the capabilities and limitations of each element in order to achieve the objectives of the system.

Revised text of conference paper CP60-1212, presented at the AIEE Fall General Meeting, Chicago, Ill., Oct. 9-14, 1960. Recommended for publication by the AIEE Computing Devices Committee.

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The authors wish to acknowledge their indebtedness to L. Rosenberg, J. Frumkin, E. B. Stroup, F. L. Greer, J. E. Gerngross, C. L. Ellis, and D. W. Kraus of the General Electric Company.

MAJOR ELEMENTS OF INFORMATION PRESENTATION SUBSYSTEMS

The Human Element. There are two essential aspects of man's role as an element of an information presentation subsystem. These two aspects relate to the needs and the capabilities of the human information user. The following discussion will summarize some of these needs and capabilities.

1. *Needs.* The information needs of the human observer stem from his task requirements. As a problem solver and decision maker he follows a number of information processing steps:

a. *Problem Recognition.* The observer must become aware of some change in the state of his environment to which he is required to react. His reaction may follow prescribed rules of procedure if the problem is a familiar one, or the reaction may require innovations if the problem is a unique one. The information presentation subsystem must be designed in such a way, therefore, as to maximize the chances that the observer will discover problems.

b. *Problem Definition.* The observer must describe the problem in terms that will most closely reflect the real nature of the change in the state of his environment. The information presentation subsystem, therefore, must present the observer with the problem-relevant data which will facilitate problem definition, since irrelevant information will degrade the observer's capability to define the problem adequately.

c. *Problem Confirmation.* The observer must have information which corroborates his initial recognition of the existence of the problem. The information presentation subsystem, therefore, must provide the observer with some technique for checking the reliability of his problem indicators.

d. *Selection of Solution Criteria.* The observer must determine what measures he will use to evaluate the effectiveness of alternative solutions to the problem. The evaluation will provide a basis for the selection of a solution. These criteria are not necessarily part of the information presentation subsystem, but they are required by the observer for the performance of his job.

e. *Hypothesis Formulation.* The observer must request and be provided with additional information which he can use to develop a solution to the problem. The information presentation subsystem must be responsive to these requests and be able

to present the observer with the kinds of data he wants in the form he wants them.

f. *Hypothesis Testing.* The observer will examine the effectiveness of one or more solutions by applying his solution criteria to them. The information presentation subsystem must provide the observer with the means for making these examinations.

g. *Hypothesis Selection.* The observer will select that hypothesis which most effectively meets his criteria.

h. *Action Selection and Feedback.* The observer will take whatever action he has decided upon which will resolve his problem most effectively. The information presentation subsystem must provide him with an indication that there has been an appropriate response to his action.

In summary, it is clear that the design of any information presentation subsystem requires clear specifications of the human observer's information needs. These needs must be met by providing the user with data that are relevant to his problems and by reducing or eliminating irrelevant data which will degrade his performance.

2. *Capabilities.* Since 80% of the information input to human beings is visual, and this article is concerned with visual display systems, the following paragraphs will be devoted to a brief outline of some important human perceptual skills and visual capabilities, namely: light sensitivity, acuity, depth perception, and color perception.[1, 2]

a. *Light Sensitivity.* The human eye responds to electromagnetic radiation within a limited range of 400 to 800 millimicrons in wavelength. Light sensitivity at a given moment is dependent upon the time that the eye has been exposed to a certain level of illumination. The full range of light sensitivity is indicated by the fact that the maximum brightness that is acceptable by the completely light-adapted eye is more than 10 billion times the threshold for the completely dark-adapted eye.

b. *Acuity.* The observer's ability to distinguish the details of an object at specified distances is affected by four interdependent, nonhuman factors:

(1) *Brightness Contrast.* There must be a significant difference between the brightness of the object and its background. When this difference is too low, at least one of the other acuity factors must be increased.

(2) *Illumination.* The object must be sufficiently lighted. If it is poorly lighted, at least one of the other acuity factors must be increased.

(3) *Time.* The observer must have more time to look at the object when the other acuity factors are low.

(4) *Brightness Ratio.* The difference between the brightness of a display and the area surrounding it should be kept low. The display or work area should be slightly brighter than its immediate environment.

c. *Depth Perception.* The observer's ability to estimate his distance from an object or to estimate the relative distance between two or more objects results from two kinds of learning. In the first place, each of the observer's eyes presents a slightly different view of an object which the observer integrates and perceives as depth. The observer also learns to perceive depth relationships from a number of other visual cues such as differences in object size, overlapping objects, apparent rate of movement, and differences in the clarity of objects.

d. *Color Perception.* Normal human observers can distinguish between 300,000 pairs of colors when they are shown side by side. But human memory is limited, and for any display situation an observer can recall and reliably match only 10 or 12 colors when they are shown at different times. Certain colors, such as orange or yellow, appear brighter than others. For this reason they may be used for attracting attention to particular items of information in a complex display. Colors also have subjective meaning for observers. Red, for example, is "exciting" or "distressing," while blue suggests "security" or "comfort."

3. *Special Human Skills.* It is a well-tried axiom that perception is selective; people see what they want to see or have been trained to see. Examples from common experience are the "animals" or other objects people see in cloud patterns or star constellations. This imaginative capability is exploited when observers perceive a structure or pattern emerging from displays of discrete events, or when a message is degarbled. The information stored in the observer's brain, and his ability to use it in conjunction with new information, varies with every individual. Thus, the interpretation of displays will not be uniform for all observers. The combined perceptual skills of several observers, however, can enhance the value of a given display.

In summary, the content or subject matter of the information displayed to the observer must be relevant to his problem-solving needs, while the form of the information must be compatible with his capabilities to perceive it.

The Machine Element. Machines are the second basic element of an information presentation subsystem. These machines or equipments have certain problems to solve, certain tasks to perform, and certain capabilities that can be exploited in system design. Presently, man must specify the exact tasks that will be assigned to the machines. Further, man must specify the precise information input, formats, information structuring (indexing), file organization, and output options desired.

The equipment in these systems consists of three components: the display, a display controller, and a display information storage. These equipment components must accomplish the tasks involved in storing, retrieving, controlling, and presenting the display information.

1. *Display Component.* With regard to the display itself, a wide range of choices exists among machine-controlled equipment available. The display devices may be classified by the types of outputs they produce; that is, devices which print, plot points and graphs, or project maps, photos, and symbols.

a. Printed outputs may be produced by typewriters, line printers, or microfilm or electrostatic printers exposed to cathode-ray tubes. The rates of display generation range from 10 characters per second to over 10,000 characters per second.

b. Graphs may be produced by devices ranging from an *X-Y* plotter to devices using the cathode-ray tube principle. The speed of such equipment ranges from 1 point per second to 20,000 points per second.

c. Charts and maps may be produced by direct optical projection or by television-type displays. The time required to retrieve one map in a file of 4,000 maps may be of the order of 10 seconds or less.

d. Pictorial display equipment includes facsimile devices, direct optical projection, and television-type systems.

These display equipments can be used in producing static displays to depict data that change infrequently or can be used in producing dynamic displays to depict data that are constantly being updated at the same time they are being used.

2. *Display Controller Component.* A second machine component is the display controller, which must handle all of the information coming into the system, send it to storage, retrieve it from storage, or process it for the display device which presents it to the decision maker and problem solver. In the present state of the art, this implies a computer. A relatively simple display controller may require just a small computer needing but a few square feet of floor space and working roughly at a rate of 100 operations per second. A very sophisticated system may require one of the large computers requiring several thousand square feet of floor space and producing millions of operations per second. In some systems it may be necessary to use the combination of both a large computer to perform a majority of the work at high speed and a small display controller to perform certain tasks independent of the large system.

3. *Display Information Storage Component.* A third machine component is the storage equipment. These machines must store information in sufficient quantities to make the system a practical and economical operation. A storage medium may be categorized according to the form of storage:

a. Digital storage systems range from punched paper tape and punched cards, a variety of magnetic devices, such as magnetic tape, drums, disks, cores, and thin films, to special devices such as cryotrons and thermoplastic tape. Access times to information on bulk storage devices range from a few milliseconds to several minutes.

b. Video storage devices include a variety of magnetic equipments and thermoplastic tape. A one-hour program can be stored on 2,500 feet of magnetic video tape, and the same program can be recorded on 250 feet of thermoplastic tape.

c. Photographic storage devices include all those devices which can record on photographic emulsions, and special devices such as thermoplastic tape.

There is a wide variety of system capabilities that can be achieved by combining the existing equipment to form an information presentation subsystem. This is evident when one considers that each of the machine components of display, display control, and display information storage has a range of four orders of magnitude in the capabilities of the equipment.

The Methodologies Element. Methods, which are the third element of an information presentation subsystem, provide an important link between the men and machines. Some of the more important methods are those concerned with:

1. *Organizing and Training People.* How to utilize the manpower resources most effectively and educate and condition personnel to accept and utilize the full capability of the information presentation subsystem.

2. *Transforming and Presenting Information.* How to classify information for efficient retrieval and manipulation, and how to display the information for effective decision making.

3. *Decision Making.* How to utilize available information effectively for arriving at decisions.

4. *Programming.* How to use the computer and other machines most effectively.

Unless the methods are carefully constructed, it is possible to amplify every error because of the speed and degree of automation in such system. This consideration imposes special requirements on systems design. First, it requires that the purposes of the organization be explicitly defined and remain relatively stable or, alternatively, that the changes in purpose be relatively predictable over a period of time. It also implies properly conducted systems analysis to ensure that the most efficient, economical system procedures are devised.

Though there are a variety of methods dealing with the organization and training of man, controlling the machines, transforming and presenting information, and integrating the system's product, we shall consider only the relationship between the methods used to control the machine in an information presentation subsystem. Programming is the general term applied to this process.

Display programming, simply stated, is the specifying and coding of the programming routines necessary to instruct a computer to generate the desired displays. A basic programming system will be described which

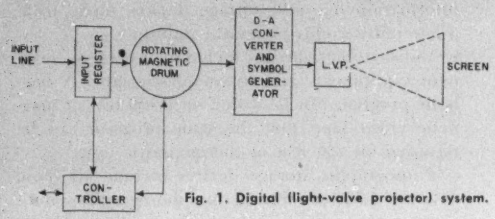


Fig. 1. Digital (light-valve projector) system.

is limited to two primary functions: generating requested displays and updating information files. A short description of the program functions and some general programming considerations for a real-time system are discussed. The program will provide a data storage retrieval capability as well as the facility for displaying data in a variety of formats, combinations, and colors. Some of the program routines are:

1. *Data Conversion.* Reads in data to construct a new file or update an existing file.
2. *Request Read-In.* Reads requests into the computer and processes the data so as to be recognizable to the interpretation routine.
3. *Request Interpretation.* Interprets the requests and initiates the operation of the necessary program routines.
4. *Map or Background Selection.* When supplementary information contained in a display request calls for a map, the map identification is automatically selected from a map inventory file.
5. *Data Retrieval.* Searches the data files, reads the appropriate data records into the computer memory, and extracts the requested information.
6. *Data Manipulation and Computation.* Provides the necessary mathematical and/or statistical capability required.
7. *Data Coding.* Converts retrieved and/or computed data into a predetermined code recognizable to the devices driving the display.
8. *Display-Controlled Data Generation.* Provides control information to the display device.

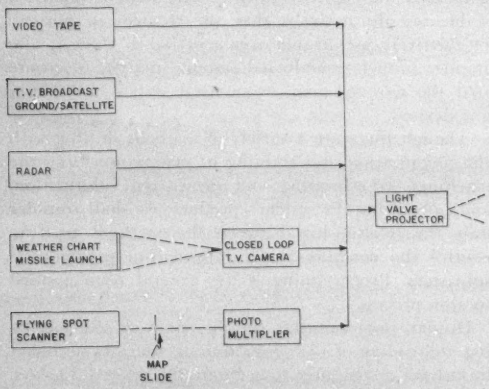


Fig. 2. Video (light-valve projector) system.

9. *Display Message Make-Up.* Formats display message.
10. *Display Storage Load.* Loads the display messages onto the storage media for storage.
11. *Display Storage Read.* Reads display off storage media onto intermediate buffer which drives the display device.

The ideal information presentation subsystem combines each of the major elements—men, machines, and methodologies—in proper balance. The machines selected must produce information which supports man in his role as a problem formulator, strategist, analyst, and action taker. The machines must enhance man's special skills of insight, pattern recognition, and extrapolation. They must relieve him of the tedious and time-consuming tasks. On the other hand, man must adapt to a mode of operation consonant with the restrictions of the machines. He must learn how to operate them and, until such time that we have adaptive systems, he must learn to communicate with them. The methodologies of information systems help to make this possible.

DYNAMIC INFORMATION PRESENTATION SUBSYSTEMS

THE DISPLAY CAPABILITIES that can be achieved with combinations of display, display control, and display information storage equipments presently available can be illustrated by discussing the various systems' configurations utilizing the General Electric light-valve projector (LVP) as the display device. The principle of operation of the LVP is discussed in the Appendix.

Each application will require that specific performance requirements and systems constraints be satisfied. However, with a computer-driven LVP, the following capabilities are achieved:

1. All forms of display can be generated at electronic speeds—textural, tabular, graphical, annotated geographical, and pictorial.
2. The display of relevant information can be presented on a screen ranging in size from 2 feet to over 20 feet square, with high brightness, high resolution, color, full gray scale, flicker data, and a full complement of alphanumeric characters and special symbols.
3. Equipment capabilities make use of most of the visual capabilities of man: acuity, recognition of shapes and patterns, brightness discrimination, detection of motion, sensitivity to intermittent light, and recognition of color.
4. A 3-dimensional (3-D) version of the LVP makes use of depth perception, which is a rarely exploited capability enabling man to perceive easily the relationships among three variables.

A wide variety of light-valve characteristics and a variety of configurations of display control and storage devices can be provided. So that the reader may appreciate the unlimited potential of display systems based on the LVP principle, several basic configurations will be described.

The configurations of equipment used with the LVP fall into two classes: that required to display digital information and video information.

1. *Digital LVP System.* A basic digital LVP system displaying alphanumeric characters, symbols, lines, vectors, and other special shapes has in addition to the LVP and a good-quality screen, the following components (Fig. 1):

a. Digital-to-analog converter and symbol generator, which converts the digital information from the rotating magnetic drum into the analog voltages needed to drive the projector electron beam, creating the desired information at the proper location on the screen
b. Rotating magnetic drum, which stores digital information and regenerates display through digital-to-analog converter/generator once each revolution
c. Input register, which acts as a buffer between the input line and the rotating magnetic drum
d. Controller, which controls flow of information from the input line to the input register to the rotating magnetic drum

The system can receive formatted digital information from computers, card or tape readers, and data links. As shown, the system has minimum control, no capability to retrieve or manipulate information, and no storage other than the active storage on the drum.

2. *Video LVP System.* As a video display, the LVP can present a large, bright, high-resolution television picture originating from any of several inputs. (Fig. 2):

a. Signals recorded on magnetic or thermoplastic video tape
b. 3-D or 2-D signals broadcast from a ground system or a satellite in space
c. A radar signal presented with a suitable scan
d. Signals from a closed-loop 3-D or 2-D television camera (standard broadcast or high resolution) picking up the image of a weather chart, a missile launching, etc.
e. Flying-spot-scanner raster scanning slides from a 3-D or 2-D map file or motion picture film

A combination of signal sources can be utilized with the provision of the switching circuitry and controls.

3. *Digital/Video LVP System.* Combining the digital and video channels provides a very flexible information presentation subsystem. Each channel can be used independently or combined. For example, the video channel driven by a flying-spot scanner can be used to display a map, and the digital channel superimposes the characters, symbols, and lines on the map. (Fig. 3)

Fig. 4 shows the components of a dynamic display system in which an optical projector is used to display maps and other backgrounds.

The following information can be displayed:

a. Textual message
b. Graph
c. Map

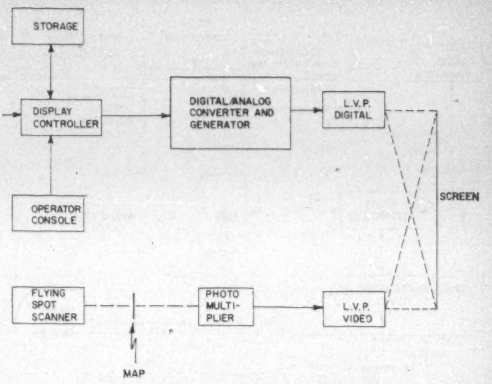


Fig. 3. Video and digital light-valve projector.

d. Symbols and lines on map as specified locations in color
e. Weather or fallout overlays
f. Vectors with annotations, or color code

When required, special procedures can be established for the controller and extra control features added to the control console which will

a. Suppress selected categories of information being displayed
b. Blink selected categories
c. Provide for display sequence control
d. Facilitate display request entry
e. Store digital display data from drum to storage
f. Transmit display data to another location

4. *Ultimate Capability of LVP Display.* The full power of the light-valve display can be achieved with the provision of a display controller with internal drum, console, and storage connected on-line as a subsystem to a high-speed computer operating as a large volume data processing system (Fig. 5). When the display controller is used as a switching center as well as a processor, display data under program control can be

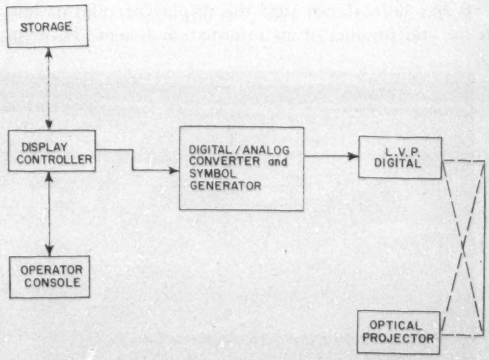


Fig. 4. Alternate video and digital light-valve projector system.

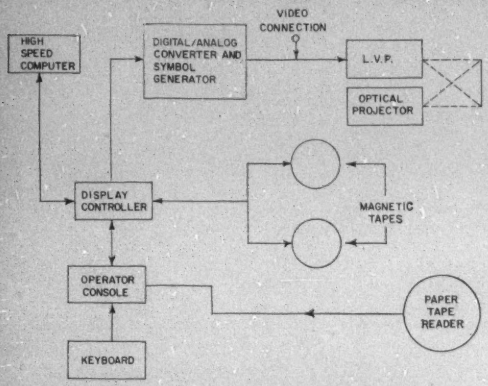


Fig. 5. Display system on line with high-speed computer.

a. Requested from display console
b. Received from large-scale computer
c. Loaded onto the display drum
d. Buffer-stored on local tapes
e. Called from buffer storage
f. Modified under local control

Heavy processing loads, e.g. large file search, map conversions, statistical calculations, and orbital calculations are performed in the high-speed computer. Formatted display data is transmitted to the display controller where it is either displayed or buffer-stored. Local control is the paramount feature of this arrangement.

CONCLUSIONS

THE CONTINUALLY EXPANDING mass of information, the growing need for a rapid exchange of information, and the general geographical dispersion of operations make effective decision making increasingly more difficult. To facilitate decision making, information systems transform the continuous flow of multitudinous facts and data received by an organization into selected, significant information, then present this information in capsule form to the decision maker for implementation.

It has been shown that the display of information is the end product of an information system. To help assure rapid and effective decision making, information display must satisfy at least two requirements:

1. The information must be relevant to the viewer's needs.
2. The form in which it is displayed should utilize most of the viewer's capabilities.

These system requirements can be satisfied by combining the three major elements—men, machines, and methodologies—in proper balance, thus achieving an effective information presentation subsystem. Such systems will enhance man's capability to receive information and perform complex tasks. A great deal can be achieved toward this end with our present knowledge of human capabilities and state-of-the-art equipments.

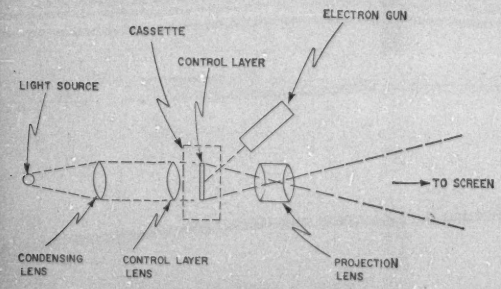


Fig. 6. Essentials of light-valve projector.

Appendix

The essentials of the General Electric light-valve projector are shown in Fig. 6. The electron gun is offset at an angle to avoid interference with the light path. An optical element, called the control layer, has been introduced to provide modulation of the light. Materials that are reusable and can dynamically become transparent or opaque with the impingement on their surface of an electron beam are not available. For this reason, the LVP utilizes a control layer that is always transparent. An electron beam deposits an electric charge on the control layer. Electrostatic force then causes a deformation of the surface as shown in Fig. 7. Since all light impinging on the control layer has been collimated, rays such as *A* are not affected by the layer but pass straight through, even though the index of refraction is greater than unity. Rays passing through the layer at points where it has been deformed, rays *B* and *C*, are refracted.

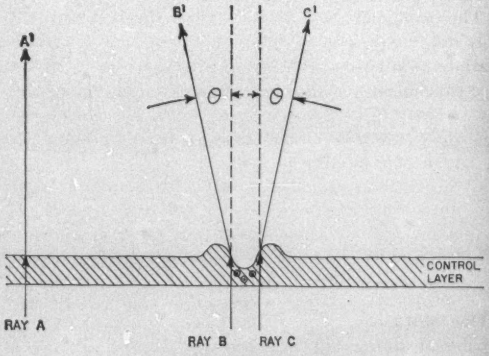


Fig. 7. Control layer deformation.

In the LVP, light is transmitted to the viewing surface wherever the control layer is deformed; it is not transmitted wherever the surface is smooth. Reference to Fig. 8 will show how this can be accomplished. Light passing through the undeformed portion of the control

layer impinges on the aperture disk and, consequently, does not reach the screen. Light passing through the deformed section is refracted sufficiently to pass by the disk and onto the screen. Since light is not absorbed by the control layer, as is the case in ordinary film-type projectors, large quantities of light can be controlled.

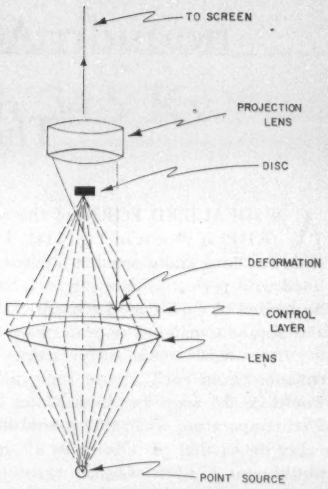
Since the point on the control surface that is deformed is the only point giving light to the projection lens, it is the only point that is "transparent" to light. Thus, the amount of light transmitted to the screen can be conrolled by the amount of deformation in the control layer; the brightness of the image is a function of the depth of deformation.

Utilizing this method of light modulation, the LVP is capable of producing any display that can be presented on a cathode-ray tube. The deflection plates of the electron gun can be fed with the proper analog voltage to write any symbol or trace for which the control equipment is programmed.

In addition, the beam can be shaped directly into symbols by a character matrix similar to that used in cathode-ray tubes of the charactron type. The application of the proper signals to the deflection plates can also produce a raster of the desired number of scanning lines on the control film. This can be done even in a gun using a character matrix by providing a circular hole in the matrix, so that the second deflection system produces the raster.

The persistence, or storage characteristic, of this display device depends upon the rate at which the deformation induced by electrostatic force subsides. This rate is primarily dependent upon the conductivity and the viscosity of the fluid. The inherent persistence of the fluid can be varied by certain additives from a very fast frame rate, such as that used for television presentations, to a long storage or persistence characteristic of several seconds. This storage characteristic allows relatively slow rewriting rates without objectionable flicker effects.

Fig. 8. Light transmission through control layer.



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1. Human Engineering (book), E. J. McCormick. McGraw-Hill Book Company, Inc., New York, N.Y., 1957.

2. Handbook of Human Engineering Data (book), second edition (revised), Tufts College, Institute for Applied Experimental Psychology. U.S. Naval Training Device Center, Port Washington, N.Y., 1952.

Choke Core Block for 6-Bev Accelerator

One of 12 components for a giant ring-type choke capable of storing and releasing 600,000 joules of energy is this core block being bonded under hydraulic pressure at Allis-Chalmers Manufacturing Company's West Allis (Wis.) works.

The grain-oriented transformer steel core blocks are for a 6 billion electron volt, 236-foot-diameter research accelerator which is expected to be in operation by mid-1961 at Cambridge, Mass., as a joint project of the Massachusetts Institute of Technology and Harvard University.

The 30- by 60-inch core blocks are bonded stacks of trapezoid-shaped laminations of 0.014-inch steel. Each weighs about 8,000 pounds and is made of six stacks about 10 inches high. Laminations in the stacks are bonded together in an oven under hydraulic pressure. The stacks are then bonded together and clamped by two end plates and four bolts.

The blocks must be precisely assembled because of the large magnetic forces which will be exerted on them. Vertical alignment is held to 1 minute of angle over the entire 61-inch length and each face must be flat within 0.010 inch.

An Electrical Essay

The Radiant Heat Pump

AN IDEALIZED FORM of the radiant heat pump (RHP) is shown in Fig. 1 (a). The box has square ends, it is long and somewhat tapered, and is completely lined with perfectly reflecting surfaces. There is a plate suspended at each end. Each plate almost fills its end, and almost touches. The plates have a black-body coating. At roughly room temperature, 27 C, the radiant emission from each square inch, all in the infrared, would be 0.3 watt. Let both plates be brought to the 27 C temperature when first placed in the box.

Let the smaller plate be 10 by 10 inches. Each surface would emit 30 watts. The 30 watts emitted to the right would all be returned by the reflecting surface at the end, to be absorbed again by the plate; thus, it drops from consideration. Let the larger plate be 20 by 20 inches, each surface then emitting 120 watts. The 120 watts emitted to the left are all reflected back to and absorbed by the plate; this energy also can be ignored. That brings us to the plate surfaces which are facing inward.

Black-body radiation emitted by a small surface area leaves in all directions, according to Lambert's law (the cosine law), being more intense normal to the surface than in any other direction. Of the 120 watts from the large surface emitted to the right, some energy goes directly to the small plate. As Fig. 1(a) shows, some energy would be reflected once before going to the other plate; and some would be reflected several times. With perfect reflectors, no energy is lost along the way. Therefore, let us attempt to get transmission of all 120 watts to the small plate, by making the box extremely long, and the taper very small. If this were achieved, the energy stream to the right would be 120 watts. The energy stream to the left, coming from the small plate, is only 30 watts. The net energy stream to the right would be 90 watts. This would be reduced by convection transfer, so let the box be evacuated.

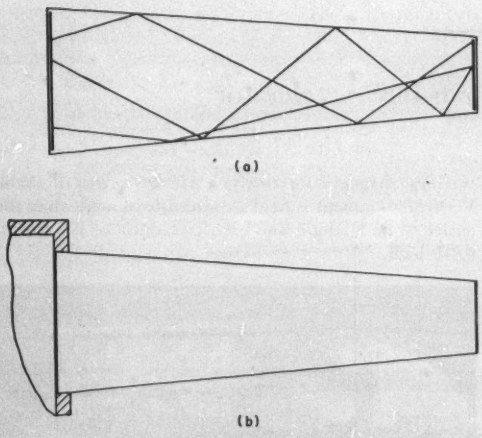

Fig. 1. Radiant heat pump: (a) idealized form; (b) practical form, applied to refrigerator.

The radiant heat pump is now working at a 90-watt rate, but this is temporary. The large plate, by losing heat, cools; the small plate, by gaining heat, warms. Would this not continue until there is an energy balance, at a net energy stream of zero?

So much for the ideal form—interesting but useless. To engineer the RHP for practical use, Fig. 1 (b), make the usual compromises with reality. Do not evacuate; convection transfer would reduce efficiency, but we accept that. Black-body surfaces and perfect reflectors are unattainable, but both can be closely approached by coatings ready at hand and in wide use. To make the box stay within bounds, shorten it and increase the taper. Even if these compromises would cut the rate from the ideal 90 watts to, say, 50 watts, there is still a rich reward. Next, remove the box end reflectors, and simply use the plates for the ends. Mount the large end in the refrigerator, as shown. The cooler large plate removes heat from the refrigerator, the RHP pumps it to the warmer small plate, and the small plate's outer surface dumps the heat to its surroundings.

The poor man's millenium having arrived, he refrigerates his foods on a do-it-himself basis. Building his own RHP, he cools his home. Come winter, he reverses the RHP to get free heat—low first cost, no maintenance, no bill from the electric company. And if some college graduate tells him his radiant heat pump violates the laws of thermodynamics, wouldn't that make him all the happier?

The RHP is hereby dedicated to the public, including that portion attending the races. A small RHP, with hinged plates, is used in moments of excitement: flap the ends open, use the box as a megaphone, and help the right horse to win. If the day gets cold, close the box, put the large plate on the ground, and as a means to an end, sit on the small plate to get warm.

A. D. MOORE (F '43)

(University of Michigan, Ann Arbor, Mich.)

Economics of Primary Distribution Voltages of 4.16 Through 34.5 Kv

J. A. SMITH

MEMBER AIEE

Cost comparisons are given for systems with primary distribution of 4.16 and 12.5 kv, as well as the more recently introduced higher voltages of 20.8 to 34.5 kv. Load densities varying from 1,000 to 32,000 kva per square mile are considered in the study.

FOR PROPER COMPARISON of the economics of systems using different primary distribution voltages, it is almost necessary to include everything from the generator terminals to the customer service drops. At the least, it is necessary to go back into the system to a common transmission or subtransmission voltage level from which power would fundamentally be made available to supply each of the distribution voltages. From this point to the customer, it is important to compare systems that utilize each voltage most economically, particularly with respect to distribution substation size.

By extending the results reported elsewhere[1] an economic comparison will be made of the traditionally used 4.16- and 12.5-kv primary distribution voltages as well as higher voltages of 20.8, 23.0 or 24.9, and 34.5 kv that have been more recently introduced.

SCOPE OF STUDY

THIS STUDY will consider all overhead systems for serving predominantly residential-type loads with 120/240-volt single-phase utilization. Comparisons will be based on costs of new systems installed to serve a given load. This neglects the same factors itemized previously,[1] particularly the influence of an existing system and conversion costs that would be required to change it to permit future expansion at another voltage.

Load densities considered will be the same; namely, 1,000, 4,000, 8,000, 16,000, and 32,000 kva per square mile. Information relating kva per square mile and demand per home is included in Appendix I.

It will be assumed that the generation and transmission system is such that power is fundamentally available at 69- or at 138-kv subtransmission. The following systems will be compared for serving 96 mva of load:

1. 2.4/4.16Y kv distribution, 2,000 kva per feeder, fed by subtransmission voltages of 69 kv, 69–34.5 kv, and by 138–34.5 kv.
2. 7.2/12.5Y kv distribution, 6,000 kva load per feeder, fed by subtransmission voltages of 69 kv, 138 kv, 69–34.5 kv, and by 138–34.5 kv. (These results also apply to distribution at 7.56/13.2Y or 8.0/13.8Y kv.)
3. 12.0/20.8Y kv distribution and 13.2/23.0Y kv distribution, 6,000 and 12,000 kva per feeder, fed by 69 and by 138 kv. (The results for 13.2/23.0Y kv also apply to 14.4/24.9 kv distribution.)
4. 19.9/34.5Y kv distribution, 6,000 and 16,000 kva load per feeder, fed by 69 and by 138 kv.

FACTORS DETERMINING MOST ECONOMICAL PRIMARY DISTRIBUTION VOLTAGE

THE COST of the most economical size distribution substations, associated primary main and express feeders, and subtransmission within the load area may be obtained elsewhere.[1] For the sake of completeness, the following additional items should also be included to compare the relative economics of serving 96 mva of load at the various primary distribution voltages:

1. Primary lateral costs
2. Losses within the load area
3. Differences in annual operating expense due to additional tree-trimming, hot stick vs. rubber gloves, etc.
4. Increased cost of sectionalizing equipment for the higher-voltage heavier-loaded feeders
5. Increased cost of fixed and switched capacitors when installed on the higher-voltage feeders

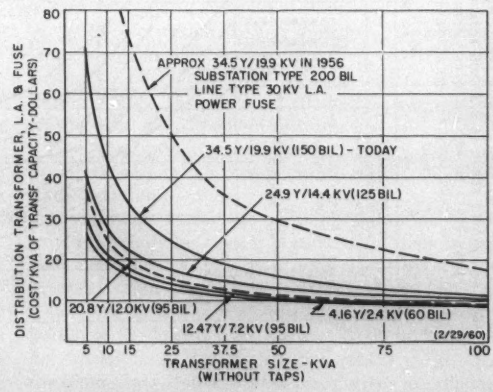

Fig. 1. Distribution transformer cost per kva of transformer capacity.

Full text of conference paper CP60-833, presented at the AIEE Summer General Meeting, Atlantic City, N. J., June 19-24, 1960. Recommended for publication by the AIEE Transmission and Distribution Committee.

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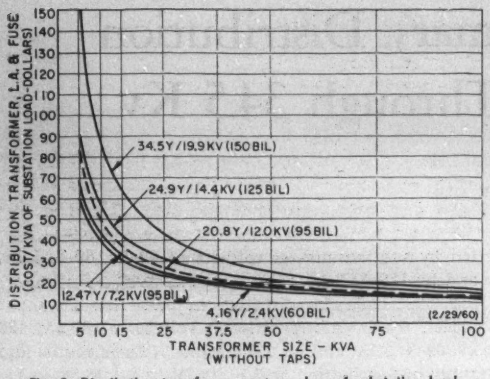

Fig. 2. Distribution transformer cost per kva of substation load.

6. Distribution transformer costs
7. Secondary costs
8. Cost for 96-mva bulk power substation to step from 69- or 138-kv source bus assumed to be at edge of load area down to 34.5 kv when this subtransmission voltage is used to supply substations within the load area

Items 1 to 5 are believed to be minor factors and, therefore, are neglected in accordance with cost assumptions listed in Appendix II. Distribution transformer costs, item 6, are shown in Fig. 1 in dollars per kva of transformer rating. It is assumed that the same size will be used to serve a given load regardless of primary voltage. This is done to reduce the number of variables in the study by permitting omission of transformer installation cost and item 7, 120/240-volt secondaries. However, it should be recognized that the most economical over-all system design at higher primary voltages will tend to have a slightly larger average size distribution transformer. Therefore, assuming the same distribution transformer size for given loads tends to penalize somewhat the higher-voltage systems. More detailed analysis of this portion of the system has shown the error caused by this assumption to be small.

Because of diversity and provision for load growth, the total kva of distribution transformers installed will be considerably greater than the peak load being served. To be on the same basis with the other system costs, the distribution transformer costs need to be in dollars per kva of load measured at the substation. The ratio of connected transformer capacity to peak load served as measured at the substation varies with load characteristics, the number of connected customers or size of transformer, and the initial and ultimate load for transformer changeout. While published information on this ratio is scarce[4-7] the values assumed in Appendix II, item 2, are believed to be typical of usual practice and loads. The data from Fig. 1 multiplied by this ratio gives values which can be used for distribution transformer cost in dollars per kva measured at the substation; see Fig. 2.

When expressed in this manner, it should be noted that distribution transformers for 12.5 kv cost from $0.50 to $7.00 per kva of load more than for a 4-kv system, depending upon transformer size. This difference has decreased over the years with increased usage of the 12.5- and 13-kv systems. For the 23.0- or 24.9-kv system, costs vary from $25 per kva more than the 12.5-kv system for small sizes to only $2 or $3 per kva more for the larger sizes.

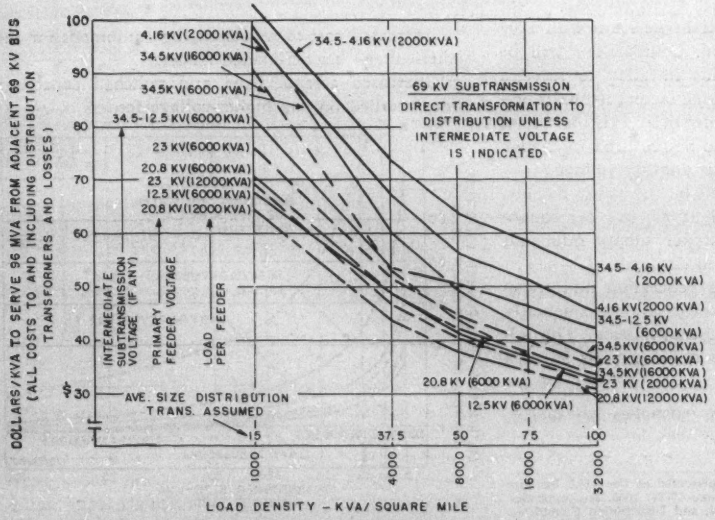
DOLLARS/KVA TO SERVE 96 MVA FROM ADJACENT 69 KV BUS (ALL COSTS TO AND INCLUDING DISTRIBUTION TRANSFORMERS AND LOSSES)
4.16 KV (2000 KVA)
34.5 KV (16000 KVA)
34.5 KV (6000 KVA)
34.5-12.5 KV (6000 KVA)
23 KV (6000 KVA)
20.8 KV (6000 KVA)
23 KV (12000 KVA)
12.5 KV (6000 KVA)
20.8 KV (12000 KVA)
34.5-4.16 KV (2000 KVA)
69 KV SUBTRANSMISSION
DIRECT TRANSFORMATION TO DISTRIBUTION UNLESS INTERMEDIATE VOLTAGE IS INDICATED
INTERMEDIATE SUBTRANSMISSION VOLTAGE (IF ANY)
PRIMARY FEEDER VOLTAGE
LOAD PER FEEDER
AVE. SIZE DISTRIBUTION TRANS. ASSUMED
LOAD DENSITY – KVA/SQUARE MILE

Fig. 3. Economic comparison of distribution voltages when power is available at 69 kv.

The 12.0/20.8Y kv system has been given little consideration until recently, although it has given satisfactory service on one system for over 13 years.[8] This system uses 12,000-volt distribution transformers connected line to ground, thus enjoying the majority of the benefits of the higher-voltage 23.0-kv system, but at considerably less cost for distribution transformers. In addition, 15-kv lightning arresters, fuse cutouts, and single-phase reclosers can be used that are more fully developed and available in higher interrupting ratings than the corresponding equipment associated with 23.0- and 24.9-kv distribution.

Today the transformers and associated equipment for 34.5-kv primary distribution are

still considerably more expensive than for the other voltages; however, the cost differential decreases rapidly for the larger sizes. One company is operating this system[9] and several others are studying it.

It should be noted that Figs. 1 and 2 are labeled as applying to transformers without taps. This is so for all data shown except for the 24.9Y/14.4-kv transformer for which "no tap" transformers are not standard. Therefore, the least expensive tapped transformer is included in this case and can be used on either 24.9- or 23.0-kv systems. If future usage and demand justify the inclusion of standard no-tap transformers for 23.0Y/13.2 kv and/or for 24.9Y/14.4 kv, the economics of these system voltages would be made slightly more favorable. With regard to item 8, distance subtransmission coverage is not included but power is assumed to be available at the end of the 96-mva load area. From this location, all costs are included to cover the load area with 69- or 138-kv subtransmission, or the cost is added for a 96-mva bulk power substation stepping down to 34.5-kv subtransmission which is used to cover the load area. Estimated cost of 96-mva bulk power substations stepping down to 34.5 kv are listed in Appendix II.

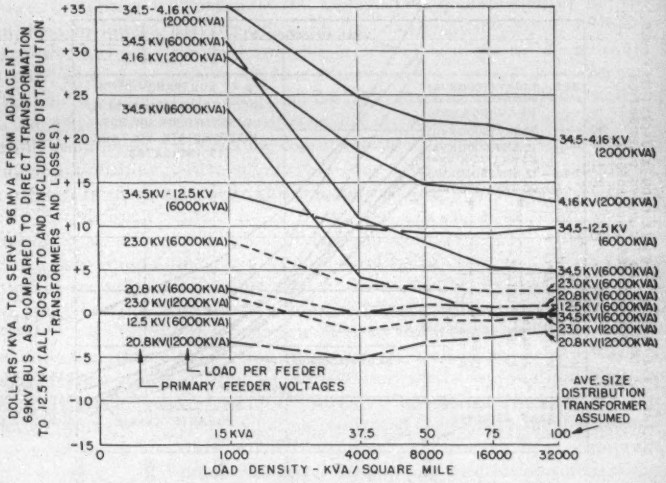

Fig. 4. Economic comparison of other distribution voltages with 12.5Y kv when power is available at 69 kv.

DISTRIBUTION VOLTAGES FED FROM 69 KV

Costs for the system layout using the most economical sizes of distribution substations were added to the distribution transformer costs in dollars per kva of load served and, when necessary, bulk power substation cost. The result is plotted in Fig. 3. The average size distribution transformer assumed for each load density is identified along the abscissa. These assumed sizes are based on reference 3 and other theoretical studies. If this average size is assumed smaller than would actually be found in practice, the higher primary distribution voltages are economically penalized as compared to the lower voltages. In practice, the system-wide average distribution transformer size, or average size by operating division, is usually known. However, few known attempts have been made to correlate the average size with demand per home and lot size or kva per square mile. More information of this type would be useful as a cross check with the theoretical studies.

Starting from the bottom of Fig. 3, the first solid line is the cost of 12.5-kv primary distribution using 6,000-kva feeders fed directly from 69 kv. Distribution at 23 kv (dotted lines) is slightly more expensive if feeder loading is held to 6,000 kva, particularly at 1,000 kva per square mile due to the higher cost for smaller size 15-kva distribution transformers. However, if 23-kv feeders were loaded to 12,000-kva feeders, savings of $1 to $2 per kva could be realized over 12.5 kv at the higher densities. Of course, these savings could be reduced by loading 12.5-kv feeders to something heavier, say in the range of 7,500 to 10,000 kva. In this regard it should be noted that 23-kv urban feeders carrying 13,000 kva have been reported.[10]

Distribution at 20.8 kv with 6,000 kva per feeder is essentially a breakeven with 12.5 kv at load densities of 4,000 kva per square mile and higher. If heavier feeder loading of 12,000 kva were used, then 20.8 kv could save from $2 to $5 per kva over 12.5 kv at all load densities considered.

The curves show that 4.16-kv distribution, either fed directly from 69 kv or by dual transformation 69–34.5–4.16 kv, is considerably more expensive than 12.5, 20.8, or 23 kv. The lower cost of distribution transformers for this system does not make up for the higher cost of substations, subtransmissions, and feeders. The single transformation 69–4-kv system is less expensive than double transformation 69–34.5–4 kv. These 4-kv curves do not include the cost of feeder regulators shown in Figs. 11 and 12 of reference 1, therefore presenting the most favorable case for 4 kv.

Dual transformation of 69–34.5–12.5 kv is shown not to be economical as compared to direct 69–12.5-kv transformation.

Distribution at 34.5 kv with 6,000 kva per feeder would generally be more expensive than other systems, except for 4.16 kv. If heavier feeder loading of 16,000 kva per 34.5-kv feeder were accepted, then 34.5-kv distribution approaches the cost of 12.5- or 20.8-kv distribution as the load density reaches 16,000 to 32,000 kva per square mile. The higher cost results mostly from the higher cost of distribution transformer installations. If the density becomes high enough or if the average

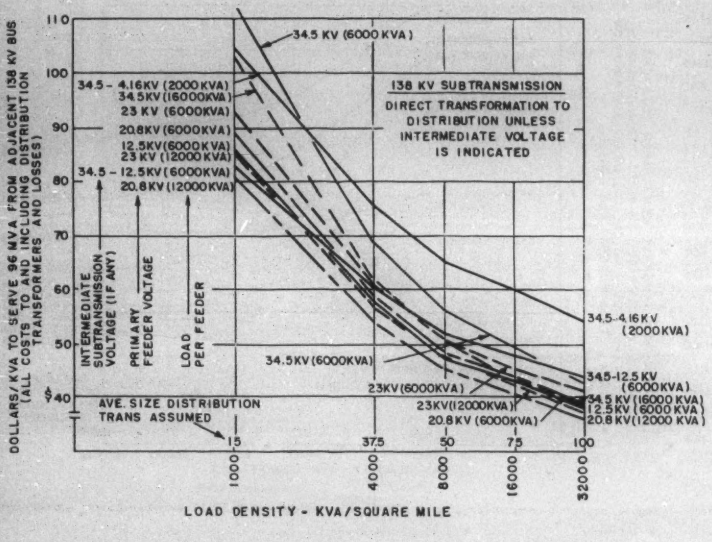

Fig. 5. Economic comparison of distribution voltages when power is available at 138 kv.

size distribution transformer becomes large enough (say due to higher utilization voltage), then 34.5 kv could break even with, or show savings over, the other systems.

Of course another possibility is that additional decreases may occur in prices of 34.5-kv distribution transformers. First serious consideration of 34.5-kv distribution began in 1956, at which time no pole-mounted designs, distribution-class lightning arresters, or cutouts were available. Considerable reduction in the cost of pole-mounted transformer installations has been accomplished as indicated by Fig. 1 due to the present availability of 150-kv BIL (basic impulse insulation level) pole-type transformers and distribution-type lightning arresters and fuse cutouts rated 27 kv. At present the distribution equipment for this 19.9/34.5Y kv system has very limited volume. If appreciable volume should develop in the future there would undoubtedly be some future reductions made in the costs. However, it is believed that these would be small and gradual as compared to what has already been accomplished.

Fig. 4 shows this same data plotted with reference to the cost of the system using direct transformation from 69- to 12.5-kv distribution.

DISTRIBUTION VOLTAGES FED FROM 138 KV

SIMILAR DATA with power available at 138 kv instead of 69 kv are given in Fig. 5. The primary distribution voltages compare in essentially the same way as when power is available at 69 kv. The most significant difference is that dual transformation 138–34.5–12.5 kv is less expensive for load densities of about 2,000 kva and below than single transformation 138–12.5 kv. This crossover is strongly influenced by the right-of-way charge for 138-kv lines.[1]

It is also of interest to compare the cost of using 69- vs. 138-kv subtransmission, assuming that power is available at 138 kv. Comparing the 138–12.5-kv system from Fig. 5 with the 69–12.5-kv system from Fig. 3, the latter results in the following savings:

Kva per Square Mile	Dollars per Kva
1,000	18.00
4,000	9.00
8,000	6.00
16,000	6.00
32,000	5.40

These savings can be compared with the approximate cost of $10.50 per kva for a 138–69-kva 96-mva bulk substation. If the size of this were increased to serve more than 96 mva, the cost could be reduced some, but it would still indicate that at the lighter densities it would be economical to transform from 138 to 69 kv, whereas at heavier densities it is more economical to go ahead and cover the load area with 138-kv subtransmission. The assumptions used herein that right of way is required for 138 kv and not for 69 kv greatly influence this and should be reviewed carefully before accepting this at face value. For example, instead of a constant $40,000 per mile, right-of-way costs might be more nearly proportional to load density. Also, this simplified study of designing entire systems from scratch neglects the influence of the existing system and future right-of-way requirements.

Fig. 6 shows this same data plotted with reference to the cost of the system using direct transformation from 138- to 12.5-kv distribution.

CONCLUSIONS

1. Of systems commonly used today, direct transformation from 69 or 138 kv to 12.5-kv distribution is less expensive, at all load densities studied, than a double transformation from 69 or 138 kv to 34.5 kv and then to 4.16- or 12.5-kv distribution except for 138–34.5–12.5 kv at 1,000 kva per square mile. A single transformation from 69 to 4.16 kv is also more expensive than 69 to 12 kv at all load densities.

The differences in favor of the 12.5-kv system over 4 kv tend to run between $15 and $30 per kva. Conversion costs to change from 4 to 12 kv have been reported from as low as $5 to greater than $90 per kva of load. Therefore, where possible, it is often attractive

to pick up new load at a higher voltage. Conversion from 4 kv to higher voltage may be justified in lower density areas that have considerable growth potential remaining. However, there are many 4-kv areas that are fairly well developed where conversion probably cannot be justified economically unless the 4-kv system has deteriorated and requires considerable rebuilding, congestion and appearance are becoming objectionable, or additional substation sites are not available. In these cases, some have found it economically justifiable to limit the 4-kv load to its present value or to a value that can be served without purchasing new 4-kv equipment. This results in gradual conversion at the edges at a rate required by load growth and equipment obsolescence.

In addition, areas may be converted for other than economic reasons, such as to make them the same voltage as surrounding areas or because higher voltage systems do not tend to be voltage limited, and therefore may not require as much attention as the load grows.

2. Direct transformation to 23.0 (or 24.9) kv distribution is slightly more or less expensive than direct transformation to 12.5 kv, depending upon relative load carried per feeder. At lighter load densities, where smaller distribution transformers are used, 23.0 kv does not compare as favorably as at heavier densities.

3. If a change to higher distribution level is being considered, 12.5, 13, or 20.8 kv appears to be the logical choice unless the existing system makes it easier to grow into 23 or 24.9 kv instead; for example, future expansion of a system which is now 69 or 138 kv to 23 kv to 4.16 kv. Here 23 kv is established as a subtransmission voltage and it is often easier and more economical to begin using it gradually for distribution as well, rather than establish a new voltage in the 12- or 13-kv class.

4. There appear to be no significant differences between 12.5- and 23- or 24.9-kv distribution that will justify consideration of converting from one to the other. The same is generally true, but to a lesser degree between 12.5 and 20.8 kv, except possibly in rural areas, which have not been covered here. In some rural applications, 20.8 kv would appear to offer increased load-carrying ability, or reduced voltage drop, and only moderate increase in distribution transformer cost as compared to 12.5 kv. At least two companies have made conversion in such areas.[11,12]

5. Direct transformation to 34.5-kv primary distribution appears to be much more expensive than 12.5, 20.8, or 23 kv unless heavy feeder loading is acceptable at load densities of about 10,000 kva per square mile and higher. This is influenced by the fact that regardless of the transmission voltage at which power is available, it is feasible to get to 12.5 kv in the same number of transformations as to 34.5 kv. Primary distribution at 34.5 kv may be less expensive than double transformation through 34.5 kv to 4.16 kv. This suggests the consideration of future 34.5-kv distribution where 69- or 138–34.5–4.16-kv systems are being expanded. This is almost another way of saying that continual review is necessary to see what minimum size load should be taken at subtransmission voltage rather than at distribution voltage.

Possible future reductions in 34.5-kv distribution transformer costs with usage do not appear to make this system attractive in the foreseeable future for extensive use in residential areas. The use of 19.9/34.5 kv may be justified for special applications such as service to industrial or commercial customers or in areas including residential load where the average size distribution transformer is increased by a significant number of larger installations used for commercial customers, pumping loads, etc. If significant usage of 240/480-volt utilization should develop, the larger-size distribution transformers permitted would make the economics of 34.5-kv primary more favorable.

6. While some lower subtransmission voltage such as 34.5 kv may be necessary in the early stages of development of a 12.5-kv system, for continued expansion it is generally uneconomical as compared to making direct transformation from the next higher system voltage available, which is usually in the 69- to 138-kv range. Precedent already exists for making direct transformation to 12- and 13-kv distribution from 230 kv.[13,14]

7. It is important that comparisons of different primary distribution voltages be based on the most economical size substation for each case. The differences in system costs for other than the most economical size

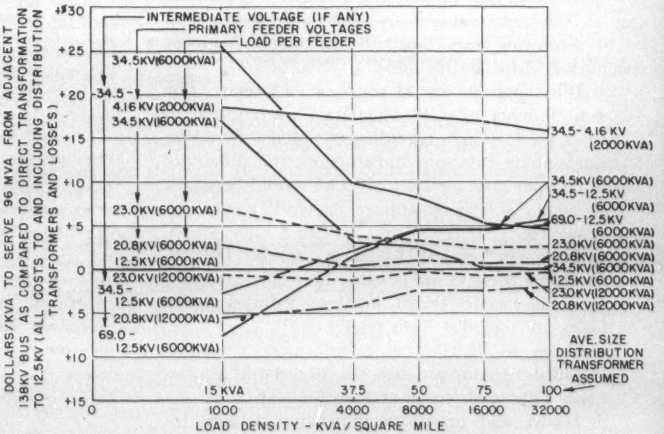

Fig. 6. Economic comparison of other distribution voltages with 12.5Y kv when power is available at 138 kv.

substation can easily be greater than differences due to the distribution voltages being studied.

8. Another important variable is the cost of distribution transformers. The relative cost of these for different system voltages is influenced greatly by the average size which should be accurately reflected into studies. The necessity of expressing distribution transformer costs on the same basis as other items cannot be overemphasized, particularly for lighter density areas where differences in diversity at different system locations have the greatest effect. In this article, all costs are expressed in dollars per kva measured at the distribution substation. Others have adjusted line and substation costs, so that everything is expressed in dollars per kva of distribution transformer capacity.[15]

Appendix I

The following table was developed from diversity curves of reference, Fig. 2, or reference 3, Fig. 6:

Load Density in Kva per Square Mile vs. Kva Demand per Home for Fully Developed Areas

	100- by 200-Foot Lots, 16 Homes per Block, 50-Foot Streets, 1,160 Homes per square mile		70- by 140-Foot Lots, 24 Homes per Block, 50-Foot Streets 2,270 Homes per square mile	
Load Density, (kva per square mile)	Single Home, Kva	Diversified, 16-Home Basis, Kva	Single Home, Kva	Diversified, 16-Home Basis, Kva
1,000	3.8	1.4	1.8	0.66
4,000	13.2	5.1	7.4	2.8
8,000	17.2	8.5	13.5	5.2
16,000	23.8	15.4	18.0	8.9
32,000	38.0	29.0	24.0	16.0

Appendix II

COST ASSUMPTIONS

Cost assumptions used for 3-phase lines and for substation equipment are itemized in reference 1, Appendix I. Additional cost assumptions used here are:

1. *Cost Items Not Included.* The following items of cost are omitted in this study as they are believed to be of secondary importance to the major items of system cost which are included.

a. Differences in cost of single-phase laterals. The same number of miles of laterals are required to cover the load area regardless of voltage. Based on single-phase ridge-pin construction, the difference in cost per mile for 2.4 to 19.9 kv should be small. If included, higher-voltage systems would be penalized.

b. Losses in primary feeder mains and laterals. Including these would penalize lower primary voltages and heavier feeder loadings. Express feeder losses are included from reference 1.

c. Losses in distribution transformers, which, if included, would penalize the higher-voltage systems. This tends to offset item *b* above.

d. Feeder and branch sectionalizing devices. Including these would penalize higher primary voltages, heavier feeder loadings, and larger substations.

e. Differences in cost of capacitors and cutouts, lightning arresters, and switching means. If included, higher-voltage systems would be penalized.

f. Differences in load coincidence factor between a 2,000-kva 4-kv feeder and larger feeder or substation loads. Including this would penalize the smaller substations, lower primary voltages, and lighter feeder loadings.

2. *Distribution Transformers.* See Fig. 1 for equipment cost including lightning arrester and high-voltage fuse cutout, as of February 29, 1960. Installation is assumed to be independent of primary voltage rating and therefore omitted. Average size is assumed to be:

Load Density, Kva per square mile	Average Size Distribution Transformer, Kva	Assumed Ratio of Connected Distribution Transformer Kva to Feeder Load Measured at Substation
1,000	15	1.88
4,000	37.5	1.65
8,000	50	1.57
16,000	75	1.50
32,000	100	1.45

Applying these ratios of connected kva to load served, Fig. 2 shows costs used for distribution transformers in dollars per kva of load measured at the substation.

3. *Installed Cost of Bulk Power Substations*

a. 96 mva firm, 138–34.5 kv, = $12.00 per kva, including 2 FOA, 80-mva transformers and 5 outgoing circuit positions

b. 96 mva firm, 69–34.5 kv, = $10.00 per kva, including 3 FOA, 40-mva output autotransformers and 5 outgoing circuit positions

c. 96 mva firm, 138–69 kv, = $10.50 per kva, including 2 FOA, 80-mva output autotransformers and 3 outgoing circuit positions

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Steady-State and Transient Ratings of Electric Wire

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THE NEED for an accurate, reliable method of determining wire ratings has been apparent for some time. Present current ratings have been in use for many years and are unduly conservative because of the large safety factors included. The idea of the large safety factors undoubtedly came from the desire to allow for all possible uses of the wire. This does not make any allowances for different environments or service for the wire. With the increasing importance of weight and cost considerations, an accurate, reliable, and easily used method of determining wire ratings has become a necessity.

A method which has been developed to calculate wire ratings as a means of meeting this necessity utilizes basic material properties of the wire involved. Essentially what has been done is to use well-known principles of heat transfer, electrical phenomena, and mathematics, arranged in such a manner that a computer can perform the many calculations necessary to predict a wire rating under any particular conditions. Predictions of the computer program have been verified by laboratory test.

The verification testing consisted of two main subdivisions. The first group of tests was set up for the determination of the materials characteristics of the wire insulation, including surface emissivity, thermal conductivity, and specific heat. The data from these tests together with physical measurements of the test wire, conductor characteristics, and the desired ambient conditions were introduced into the computer program. The computer program produced predictions of current ratings at the various desired conditions.

The second group of tests consisted of actual verification of the program predictions. These tests were conducted in a chamber where various ambient conditions can be produced. The actual rating of the test wire was then determined for steady-state and transient conditions at the imposed ambients.

Steady-state tests were conducted on two different sizes of two different types of wire—a total of four complete verification tests. Each test wire was tested at three different ambient temperatures and at altitudes of sea level, 50,000 feet, and 100,000 feet. Predictions were well within 10 per cent of test results, as shown in Fig. 1. Inasmuch as errors may be present in both calculated and test values, the error in the calculations is probably less than 5 per cent. It should also be noted that the predicted results consistently err on the conservative side.

Transient tests were conducted on the same four test wires used for steady-state tests. The wires were tested at the same altitudes but only one ambient temperature, because it was desired to keep the transient temperature rise within the continuous rating, thus limiting the available range of starting temperatures. Predictions were within 10 per cent of test results, again implying that computer errors are probably less than 5 per cent.

All verification testing was done on single wires. The authors did no verification testing of wires in bundles and do not contemplate doing so, inasmuch as the Naval Research Laboratory is doing this work. At the present time, indications are that the bundle calculations can be considered to be within desired limits of accuracy.

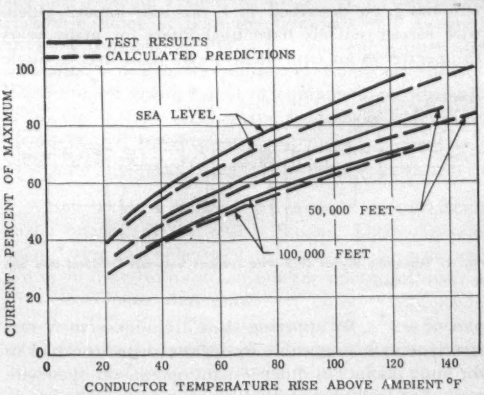

Fig. 1. Comparison of steady-state test results and computer program predictions.

The wire rating computer program is considered to be verified by test as accurate enough to be used as a design tool. It is valid for any ambient condition or installation under steady-state or transient conditions. The program has flexibility in the time–temperature domain, and yields directly usable, easily understood results. It is applicable to both direct-current and alternating-current circuits. Finally, it is considered to be useful in design of both single-wire and bundle installations. Use of this computer program will result in significant weight reductions and cost savings through better designed installations.

Digest of paper 60-1220, "Calculation of Steady-State and Transient Ratings of Electric Wire," recommended by the AIEE Insulated Conductors Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Fall General Meeting, Chicago, Ill., Oct. 9-14, 1960. Scheduled for publication in AIEE *Power Apparatus and Systems*, Feb. 1961.

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2-Wire Operation of *N* Carrier Systems

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The sharp increase of population in the San Francisco Bay area in California has expanded industry and greatly increased home ownership. The resultant demand for telephone circuits has created a cable and conduit problem which The Pacific Telephone and Telegraph Company is attempting to solve by means of an experiment that intensifies the utilization of the existing cable plant.

THE *N1* carrier system was designed to provide 12 2-way conversations on two nonloaded cable pairs or a quad within the same cable sheath, using separate pairs and a different frequency band for each direction of transmission: the low-frequency band 44 to 140 kc in one direction and the high-frequency band 164 to 260 kc in the other. The *N1* carrier system has been described in a previous paper.[1] Open-wire carrier systems have used filters for many years to operate on an equivalent 4-wire basis over a single

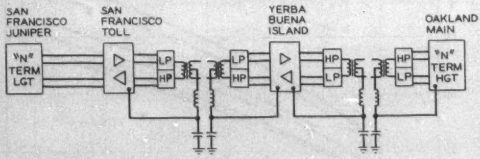

Fig. 1. Schematic layout of 2-wire systems between Oakland and San Francisco Juniper.

pair of wires. By applying these techniques to *N* carrier systems it is possible to operate them in cables in the same manner as other systems operate on open-wire pairs. For lack of a more descriptive term, the systems operated in this manner have been designated "2-wire *N* carriers," and will be referred to as such in this article.

GENERAL

THE CABLES crossing the San Francisco Bay were selected for 2-wire *N* carrier system trials because of the paired and/or quadded cables that were available. The Pacific Telephone and Telegraph Company installed four of these systems using Lynch Communication Systems, Inc. *F-1154* filters. The information received from testing these systems can be used as a guide for engineering of similar systems. Fig. 1 shows a schematic layout of the two systems installed between San Francisco and Oakland. Fig. 2 shows a schematic of the two systems installed between San Francisco and San Rafael. The systems between San Francisco and San Rafael will be the one more fully described in this article because they are more complex.

The first two experimental systems were installed between the San Francisco Juniper and Oakland Main offices, with repeaters at San Francisco Toll office and Yerba Buena Island Repeater Station. These systems were operated 4-wire in 19-gauge quadded toll cable between San Francisco Juniper and San Francisco Toll offices. From San Francisco Toll to Yerba Buena Island and on to Oakland Main the systems were operated 2-wire in 19-gauge paired submarine cable.

After these systems were put into operation and thoroughly tested with satisfactory results, they were turned over to regular traffic use for a trial period of 6 months. The following five different types of traffic circuits were assigned to these two systems: two full-period leases, four foreign exchange circuits, nine crossbar tandem to crossbar tandem, four crossbar tandem to *4M* switching machine, three *3CL* switchboard to *4M* switching machine. During this trial period no circuit outages or system trouble was experienced.

The second two systems, those with which this article are most concerned, were installed between the San Francisco Main and the San Rafael office. These systems were operated 2-wire from San Francisco Main to San Rafael in 19-gauge quadded cable, with a system working on each side of a quad. There are two repeaters between these offices, as shown in Fig. 2. The

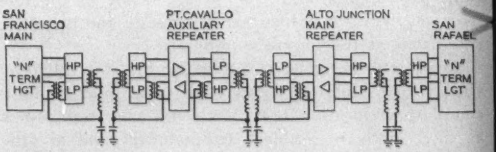

Fig. 2. Schematic layout of 2-wire systems between San Francisco Main and San Rafael.

one nearest San Francisco Main, Point Cavallo, is an auxiliary repeater and normally receives its power from San Francisco. The one nearest San Rafael, Alto Junction, is a main power point. The section between San Francisco Main and Point Cavallo is 6.85 miles in length, and is partly submarine cable. The section

Essentially full text of paper 60-998, "Two-Wire Operation of 'N' Carrier Systems," recommended by the AIEE Wire Communication Systems Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Pacific General Meeting, San Diego, Calif., Aug. 8-12, 1960. Published in AIEE *Communication and Electronics*, Nov. 1960, pp. 594-97.

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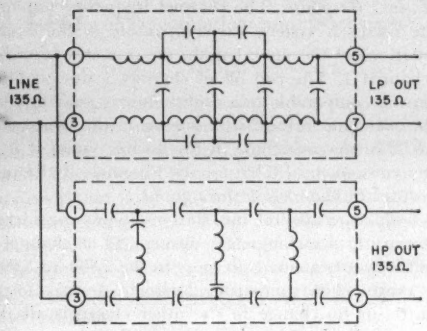

Fig. 3. Schematic of *F-1154* high-pass low-pass filter.

between Point Cavallo and Alto Junction is 6.67 miles and is buried cable. The section between Alto Junction and San Rafael is also buried cable and is 7.20 miles in length.

The conversion to 2-wire from 4-wire on these systems and the testing procedures were as follows:

Both systems were lined up on a 4-wire basis. Noise, crosstalk, and channel response tests were then made on both systems. The first system was then converted to 2-wire operation in the section between San Rafael and Alto Junction repeater. All noise, crosstalk, and channel response tests were then repeated. This procedure was repeated one section at a time until the system was operating 2-wire from San Rafael to San Francisco. The second system was then converted to 2-wire in the section between San Rafael and Alto Junction on the pair left idle when the first system was converted to 2-wire. The system continued to operate 4-wire on its own quad between Alto Junction and San Francisco. All noise, crosstalk, and channel response tests were then repeated on both systems. This procedure was repeated for each section until both systems were operating 2-wire, one on each side of the same quad from San Francisco to San Rafael.

FILTER DESIGN

THE LOW-PASS HIGH-PASS directional filters were designed by Lynch Communication Systems, Inc. These provide a minimum loop rejection of 60 db, pass all frequencies below 140 kc on the low-pass side and pass all frequencies over 160 kc on the high-pass side. The schematics of the filters are shown in Fig. 3. The balanced arrangement contains 4 coils and 8 capacitors for the low-pass side, while the high-pass contains 3 coils and 10 capacitors. The impedances in and out are 135 ohms balanced. The frequency response of the filters is shown in Fig. 4. The pass band losses for the two channels adjacent to the filter cross-over does not vary more than ½ db at the corners. The attenuation at the cross-over point at 150 kc is a minimum of 30 db to ensure the 60-db minimum loop loss requirement. The reflection coefficient in both pass bands at no point exceeds 10%.

The high-pass and low-pass elements of the filter are separately packaged in a hermetically sealed container measuring 3¼ by 3⅜ inches by 4⅛ inches high. Two complete filters (four containers) required for one repeater are mounted on a 3½- by 19-inch mounting plate, which is arranged to include the battery-feed isolation filters for each side of the repeater. Fig. 5 shows a schematic of the repeater filter and network panel and Figs. 6 and 7 show the pictures of the filter panel. The center container holds the battery-feed isolation filters exposed in the front view of Fig. 6.

FILTER INSTALLATION

THE FILTERS used for the experimental systems were installed for convenience of cutover from 4-wire to 2-wire and not for maintenance or flexibility. At the terminals, the filters were installed in vacant bay space close to the terminals. At the repeater points, they were installed close to the frame for convenience of swinging jumper wire.

In a permanent 2-wire installation, the filters should be installed near the frame or cross-connect terminals, with both equipment and line side of the filters appearing on frame or terminals, whichever is used. This should be done at both the terminals and repeaters to allow complete flexibility for reassigning filter and associated repeaters for routine or emergency maintenance, or for reassignment of equipment to other systems. Fig. 5 shows a schematic diagram of a repeater, its filters, and building-out equipment.

TRANSMISSION CONSIDERATION

Noise. Table I shows a set of noise measurements taken on one of the tested systems. These measurements were taken between the hours of 11 p.m. and 7 a.m. in order to have a minimum amount of disturbance from office dial noise. All noise measurements were made with a *2B* noise-measuring set calibrated 144 and read *F1A* weighted. The noise measurements shown in Table I were made at the +10 point on the channel units (E_1, E_2 jacks), but they have been corrected and are all in decibels adjusted (dba).

If a 2-wire *N* carrier system were to be installed in a route where no power feed was required to auxiliary repeaters, it would still be necessary to use the transformer with a center tap to ground for suppression of

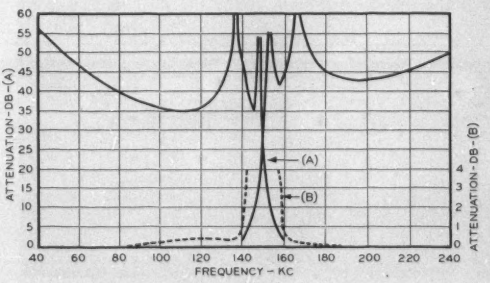

Fig. 4. Response curve of *F-1154* high-pass low-pass filter.

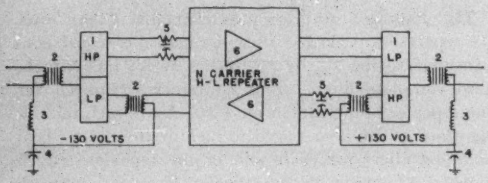

Fig. 5. Detailed schematic of repeater showing filters and power feed.

longitudinal noises on the line side of the filters. (See Fig. 2, San Rafael-to-Alto Junction section.) This was found to be necessary in both experimental installations.

As can be seen in Table I, noise begins to increase noticeably as the third section is converted to 2-wire. Calculations based on these measurements (Table I) indicate that a limit of about five repeater sections should be set on a 2-wire system having repeater sections of between 6 and 7 miles in length. The amount of noise in a different 2-wire *N* system of three repeater sections could be less than the one covered here if the repeater sections were shorter. This is true because the artificial lines and/or span pads used to build out a repeater section are on the 4-wire side of the filters and therefore would add more attenuation in the loop around a repeater. This can be seen in Fig. 5.

Crosstalk. The two systems covered in this article were checked for both near-end and far-end crosstalk. The only measurable near-end crosstalk that was found showed up as intra-channel side tones. The highest side tones measured were still down to about —50 dbm. Most channels were in the order of —60 to —65 dbm. These side tones also appeared in the experimental systems in paired cable, but were not of any consequence.

There was a small amount of far-end crosstalk that could be measured with the measuring equipment available. This only appeared when the systems were operating 2-wire for two sections, and 2-wire for three sections. If the far-end crosstalk had been intelligible, it could have been reduced to unintelligible babble by switching systems from one quad to another at repeater points.

There was no measurable far-end crosstalk on the systems that were tested in the paired cable.

Table I. Noise Measurements in DBA Corrected to 0 Point

Channels Measured	4-Wire—3 Sect.	2-Wire—1 Sect. 4-Wire—2 Sect.	2-Wire—2 Sect. 4-Wire—1 Sect.	2-Wire—3 Sect.
1	10.1—11.1	11.7—13.7	11.6—12.6	15—16
2	16.6—17.6	12.7—13.7	12.1—14.1	16.1—17.1
3	15.8—17.8	11.6—12.6	10.6—12.6	16.7—17.7
4	12.4—13.4	14.6—16.6	14.6	18—20
5	9.2—10.2	14.4—16.4	13.2—14.2	14.2—15.2
6	10.2—11.2	13.5—15.5	11.3—12.3	14.3—16.3
7	10.4	10.5	11.3—12.3	16.3—18.3
8	11.9—12.8	5.4	11.7—12.7	15.7—17.7
9	8.4—9.4	8.7	11.4—13.4	12.3
10	7.5—8.5	7.7	8.7	10.7—12.7
11	9.8—10.8	12.9—14.9	12.8—14.8	14.2—16.2
12	15.00—16.0	12.1—14.1	13.1—14.1	13.2—16.2

Channel Response. The channel frequency response of the 2-wire *N* system was comparable to the 4-wire installations of the same length, the one exception being channel 1. The roll off of channel 1 due to filter action was comparable to a slightly longer system. This can be overcome in the 2-wire systems in the same manner as it is now overcome in the 4-wire system if it is of any consequence. That is, use channels 2 through 13, instead of channels 1 through 12.

In both experimental installations it was considered unnecesary to use channels 2 through 13 as channel 1 roll off was only about 1 db more in the 2,800- to 3,000-cycle range when comparing 2-wire to 4-wire. There was little or no change in the other channels all the way across the frequency band.

POWER

THE POWER FEEDING of auxiliary repeaters presents a problem in a 2-wire system. This problem, however, only exists if there is more than one auxiliary repeater between power points. The principle use of 2-wire *N* carrier will be in metropolitan areas. This means repeaters can be located in central offices with an occasional auxiliary between mains.

In both experimental installations there was only one auxiliary repeater between power points. In the case of the Oakland to San Francisco Juniper systems, San Francisco Toll fed negative 130 volts to Yerba Buena Island repeater station on the first system, while Oakland fed positive 130 volts. This arrangement uses a ground return. However, by having San Francisco Toll feed positive 130 volts on the second system and Oakland feed negative 130 volts, the ground currents were equalized. If this method is followed with all 2-wire systems through a cross section, the maximum current through ground return would be one system unbalance when an odd number of systems were installed. This method of alternately feeding positive and negative voltage was also the method used on the systems between San Francisco and San Rafael, San Francisco Main being one power plant and Alto Junction being the other.

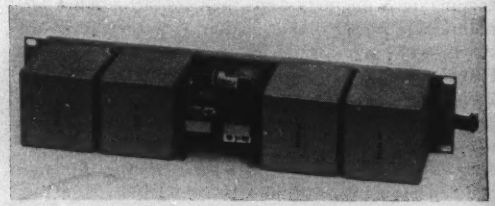

Fig. 6. Filter mounted on plate, cover removed to show power-feed filters.

At an auxiliary repeater that has both 2-wire and 4-wire system, the repeater mountings will not be strapped the same for receiving power from a remote supply. If at any time there should be a need to trans-

fer equipment from a 2-wire to a 4-wire, or vice versa, the strapping of the mountings must be changed.

LINE-UP AND MAINTENANCE

THE 2-WIRE *N* carrier systems require no special equipment for line-up or maintenance. In lining up these systems the standard procedures should be followed. This is possible because this arrangement of 2-wire operation is actually a change in the facility over which the system is operating, and not a change in the system itself. This facility change does mean, however, a change in power-feed arrangements and must be remembered for maintenance or reassignment. (See power section.)

CONCLUSION

BASED ON THE DATA received from the experimental systems, it has been demonstrated that *N1* carrier systems can now be operated 2-wire for short distances, using available equipment, without exceeding the transmission limits of the systems.

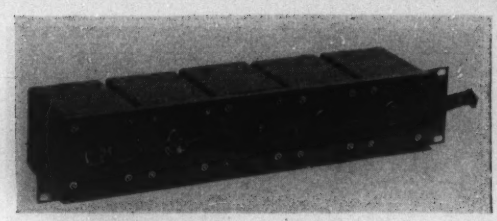

Fig. 7. Back view of filters showing wiring.

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1. A New Telephone Carrier System for Medium Haul Circuits, R. S. Caruthers, H. R. Huntley, W. E. Kahl, Ludwig Pedersen. *Electrical Engineering*, vol. 70, 1951, pp. 692-97.

Standardization of Electronic Instrumentation and Control Systems

J. G. NISH

The design and construction of elaborate electronic systems for instrumentation and control of test and research facilities is guided by principles and practices of standardization which reduce system cost and completion time. A summary of these standardization principles and practices is presented.

WEAPONS test installations, nuclear reactors, wind tunnels, and all other such huge test and research facilities are the tools required to implement modern research and development programs. The evolution of these large-scale test and research facilities has, in turn, made necessary the companion development of large-scale, complex, electronic systems for their instrumentation and control.

The University of California Radiation Laboratory (at Berkeley and Livermore Sites) has long been active in these fields of work—nuclear devices for weapons and peaceful use, particle accelerators, controlled nuclear fusion, nuclear propulsion, and investigation of outer space—all of which fields require the development and use of such large-scale test and experimental facilities. Consequently, the development of increasingly larger and more complex electronic systems for instrumentation and control of these huge research facilities has been a continuing activity at this laboratory for many years (Fig. 1).

This laboratory was fortunate in that, from the very early stages of development of such systems, it stressed the attainment of as much standardization in design and construction of those systems as is practicable.

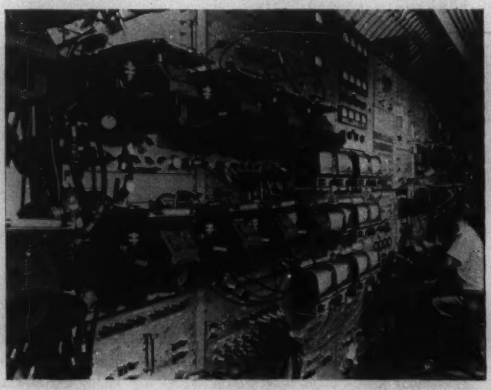

Fig. 1. Control Room, weapons test installation.

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The standard practices described in this article are the composite result of contributions by many engineers and technical people in the Electronics Engineering Deparments of the Lawrence Radiation Laboratory at both Berkeley and Livermore sites. The work was performed under auspices of the U. S. Atomic Energy Commission.

Fig. 2. Basic Lawrence Radiation Laboratory electronic system design principle: Instrumentation and controls for research or test facility (machine at right) are concentrated on multiple rack at central control point (control station at left).

Therefore, this laboratory has, by a process of steady accumulation, built up a considerable body of standardized design and construction practices for large-scale and complex electronic systems. The result of this has been that such systems are designed and built here at far less cost and in much less time than is usual for such large-scale electronic installations.

STANDARD DESIGN PRACTICES

DESIGN STANDARDIZATION is achieved by adherence of each system to these basic design principles:

1. All instrumentation must be mounted in relay racks joined together to form a continuous wall. At one point on this wall is located a control console, thereby making all operations of the test or experimentation facility controllable from a single control center (Fig. 2).

To implement this design principle, a standard relay rack was evolved which is characterized by these unique features:

a. The rack is made of heavy-gage angle iron and is jig-welded, thereby assuring a rugged structure which can be shipped, even with full equipment installed, over great distances (Fig. 3).

b. The rack frame is mounted on a U-beam channel base, thus leaving a trough for cables below the rack, so that the entire rack can be mounted directly on the building floor without constructing cable trenches or leaving exposed cable runs on the floor (Fig. 4).

c. The rack frame is so rugged that only two cross pieces, across the top, are required (Fig. 5). This leaves a clear, unobstructed working space inside each individual rack (Fig. 6), and forms a continuous unobstructed space inside the entire multiple rack. This clear space affords a tremendous advantage in ease of installation and servicing of equipment within the rack.

d. In addition to the above major design features, the racks incorporate these two minor ones which afford great convenience in installation and servicing: (1) The rack angle iron is of L-shaped cross section with the short leg of the L forming the front face of the rack. This permits a larger-than-usual open width at the front of the rack while retaining the proper distance between holes for mounting standard 19-inch-wide panels. The extra width of front opening (18 inches instead of the 17¾ inches specified by MIL STD 189) provides needed clearance for mounting chassis supporting slides. (2) Rack-mounted panels are secured to the rack by screws with large knurled heads which can

Fig. 3. Standardized racks are accurately aligned and rugged due to jig-welded, heavy angle iron frames. Racks are totally enclosed by standard panels screw-fastened to rack framework.

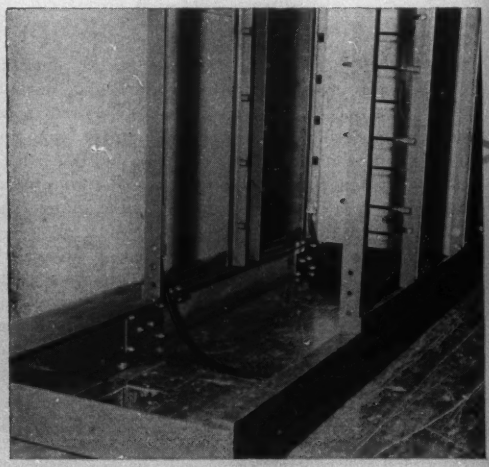


Fig. 4. Standardized racks are mounted on foundations formed by channel beams; beams permit mounting racks directly on floor and provide cable duct which eliminates need for building cable trench under rack.

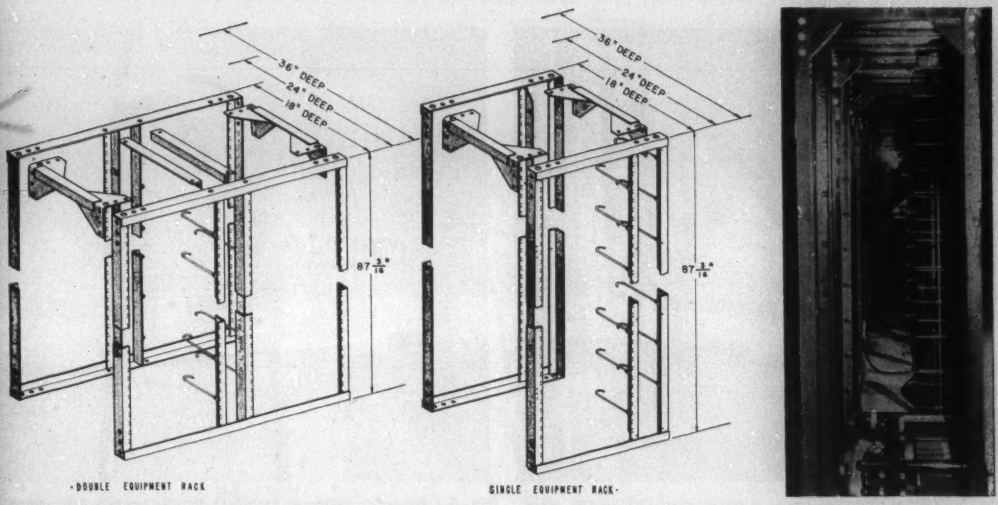


Fig. 5 (*left*). Because of rugged frames used, standard racks require cross members only at top. Fig. 6 (*right*). Because of rugged frames and absence of cross members, standard racks have clean unobstructed space inside each individual rack.

be turned by hand. This eliminates need for using a screwdriver when installing or removing chassis from the racks.

2. A second standard design principle is that all testing and checking, as far as practicable, shall also be possible from this single control center. Therefore, in addition to equipment racks, the control center has an appropriate number of telephone-industry type "cross-connect" racks at which all system circuit connections are made (Fig. 7). The advantages of this arrangement are:

a. All important check points can be tested rapidly, and the operational changes produced by changed circuit connections can be observed immediately on the adjoining control board. This affords great time savings in servicing, which savings are especially great for preventive maintenance, particularly where complex check-out procedures are required.

b. A further advantage of this "central connection point" principle is that, in the event of the failure of some circuit element, it is not necessary to enter a hazardous area to remove the faulty element and replace it with another for this can often be done by making suitable circuit connection changes at the cross-connect rack (Fig. 8). A consequence of this is that a huge accelerator or other large research facility can often be kept in operation till the end of a run instead of being shut down by a component failure. The resultant saving in cost of machine down time is tremendous.

3. The third guiding principle on the basis of which system design has been standardized is this: At each control console there shall be provided a single, lock-controlled switch which can not be operated unless a whole chain of required interlocks are in safe condition, thus providing a central-point check of the safety of the whole system's operation.

To implement this principle, these two standard construction practices are followed:

a. Interlock chains, comprising a series of colored indicator lights, are arranged in a horizontal row at or near the control console. Each light going on indicates a "safe" condition at a particular location or at a particular stage of operation. Thus, a continuous string of "on" lights indicates at a glance safe operating conditions throughout the system. (See panel in front of operator, Fig. 2.)

b. In addition to the safety interlocks there is located in each hazardous area a "safety box" which houses a switch (Fig. 9) that can be operated by a person in the hazardous location to interrupt the

Fig. 7. Basic design principle of Lawrence Radiation Laboratory control systems: Control system connections are brought to terminal boards in cross-connect rack (open cabinet at left) located near control console, to permit connections to all system units at central control point.

Fig. 8. "Central connection point" at cross-connect rack permits making control system changes at control station instead of in hazardous or distant areas where control system elements are located.

Fig. 9. "Run-Safe" switch at hazardous location permits interrupting control circuit to prevent system operation while personnel are in hazardous area.

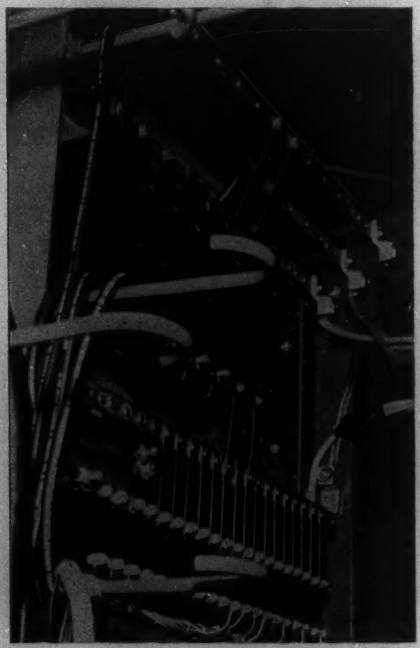


Fig. 10. In power control rack, highest voltage equipment and wiring is located at top, for maximum safety (to minimize accidental contact with high voltage).

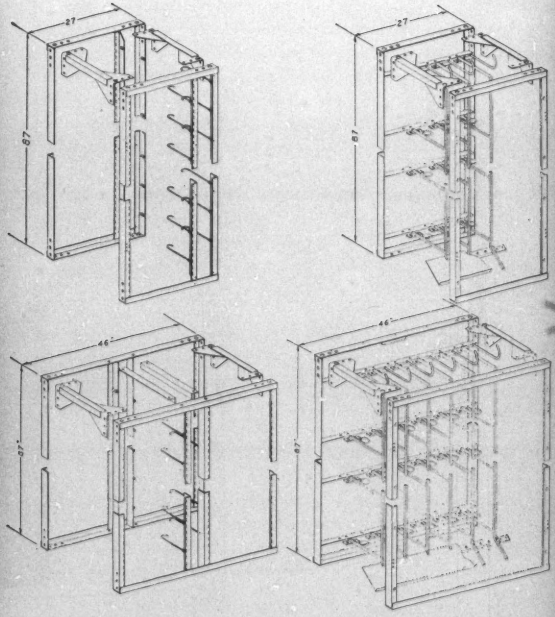
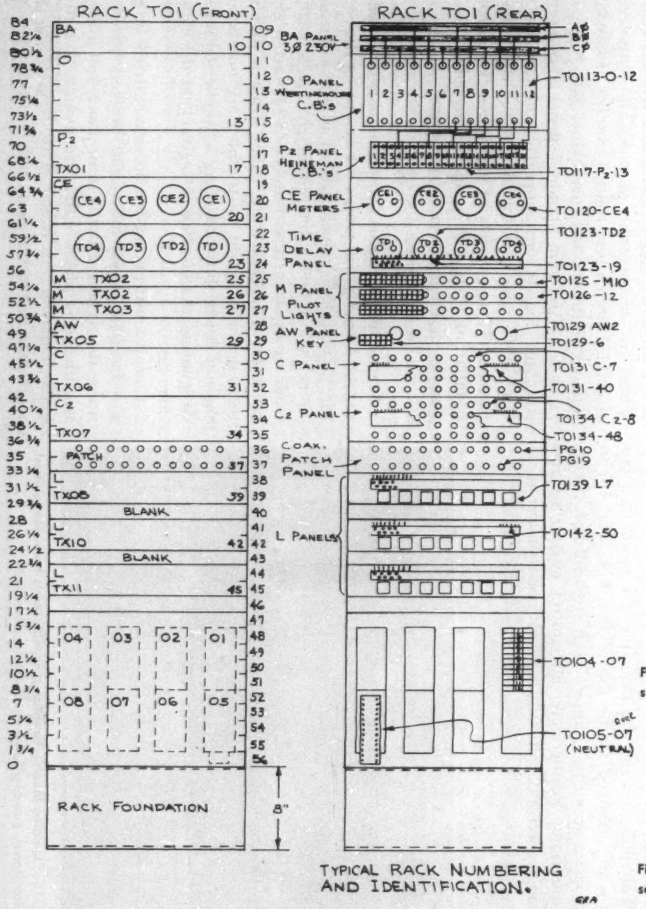


Fig. 11. Standard cross-connect racks follow interchangeable front-and-rear frame practice of relay racks. Also, internal structure for support of terminal blocks is made up of standard supporting rod elements.



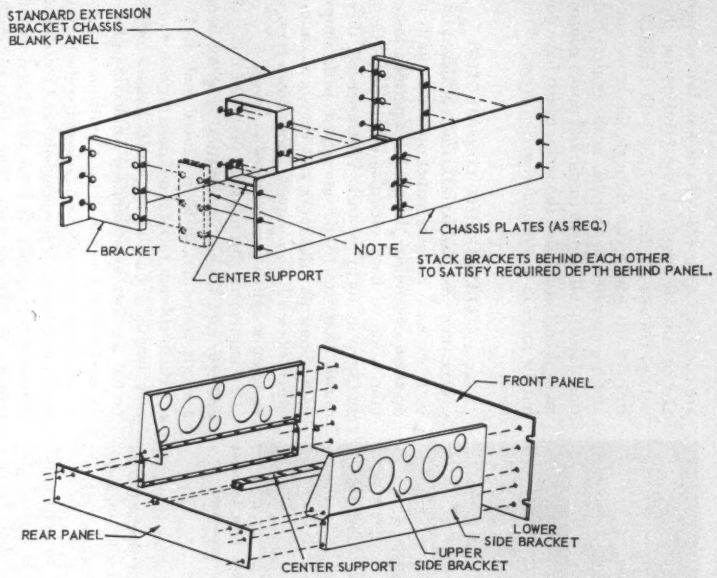


Fig. 13. *(above)* **"Erector set" construction of standardized Lawrence Radiation Laboratory chassis from standard, modular brackets and subchassis plates.**

Fig. 12. *(left)* **Standardized chassis construction. Modular-height chassis front panels, and numbering scheme to indicate panel location on the rack.**

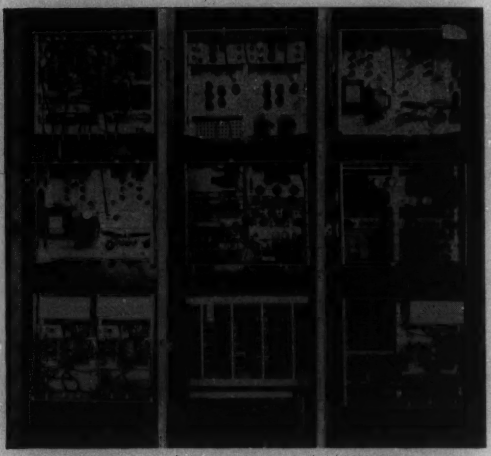


Fig. 14. Variety of chassis constructions obtainable from Lawrence Radiation Laboratory modular, standardized chassis components.

control circuit, and thus to prevent operation of the experimental equipment that would endanger the person caught in that location.

4. A fourth principle that is observed to help standardize the designs of electronic systems is this: As far as is practical, power feed and controls shall be concentrated on a single rack of the entire multiple rack installation and shall be arranged inside the rack for maximum safety.

For implementing this principle, the power-feed bus bars are arranged at the top of the rack (Fig. 10) to minimize accidental contact with high-voltage circuit connections. Furthermore, all control circuits to and from the central connection point (cross-connect rack) are energized with 120 volts or less. Where higher voltage circuits are required, the breakers for these high-voltage circuits are remotely controlled by 120-volt control circuits which run through the cross-connect rack and are operated by switches at the central control station. Finally, all the electronic and power control equipment is enclosed inside the racks, which have doors with handle locks to avoid unauthorized access to the equipment.

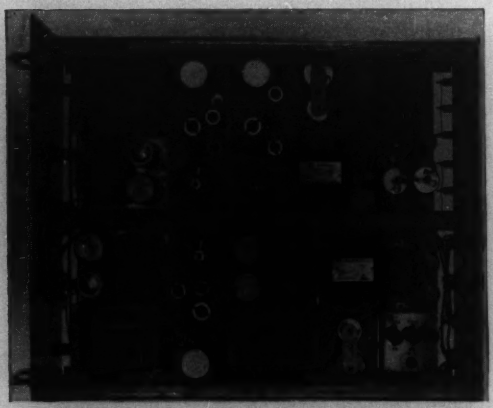


Fig. 15. "Building block" construction of full chassis from standardized, prefabricated, power-supply, and regulator subchassis.

STANDARDIZED CONSTRUCTION

CONSTRUCTION STANDARDIZATION is achieved by making both the racks and the panel or chassis units mounted on them of modular design. This permits low-cost prefabrication of basic modular components in quantity, and keeping them in stock. When needed, they can be drawn from stock and assembled with simple hand tools. Consequently, racks and chassis modules can be stored efficiently in compact, knock-down form, and can be rapidly built up as required.

To implement this modular design of racks, the front and rear rack frames are identical (Fig. 5); hence, only a single frame has to be produced and stocked. Also, the channel-beam rack foundations are made in a single-rack length, a number of which lengths may be connected together by a standard connecting plate to produce a foundation (Fig. 4) for a multiple rack composed of any desired number of rack units. Furthermore, all rack doors are made of a single hinged panel which may be inverted to change it from a left-hand opening to a right-hand opening door. The racks are enclosed by bolting standard side, top, and rear panels to each rack frame. A standard, inclined-surface console panel is also provided, which may be assembled onto any rack frame. Thus, any combination of racks and consoles can be assembled from a very limited number of standard rack foundation, frame, and cover panel parts. Cross-connect racks have different standard doors and an internal structure (Fig. 11) for support of the terminal boards, but use the same rack foundation and cover plate components. Thus a variety of multiple-rack control center installations (Figs. 1, 2, 7) can be achieved from a limited number of standard, modular parts.

CHASSIS

STANDARDIZED chassis construction is achieved by using modular vertical panels for mounting the chassis on the racks. These panels are all of the same standard 19-inch width but of different heights, each height being made up of an integral number of 1¾-inch-high modular units. The rack front panel space is divided into these modular height units which are numbered from the top down, thus providing a numbering scheme for designating the location of a panel on the rack frame (Fig. 12).

Chassis construction is also standardized by making the chassis of standard modular brackets which form a frame that is bolted to the front panel, and using modular subchassis plates which are mounted vertically or horizontally on this frame. This "erector set" type of construction (Fig. 13) permits fabricating chassis of up

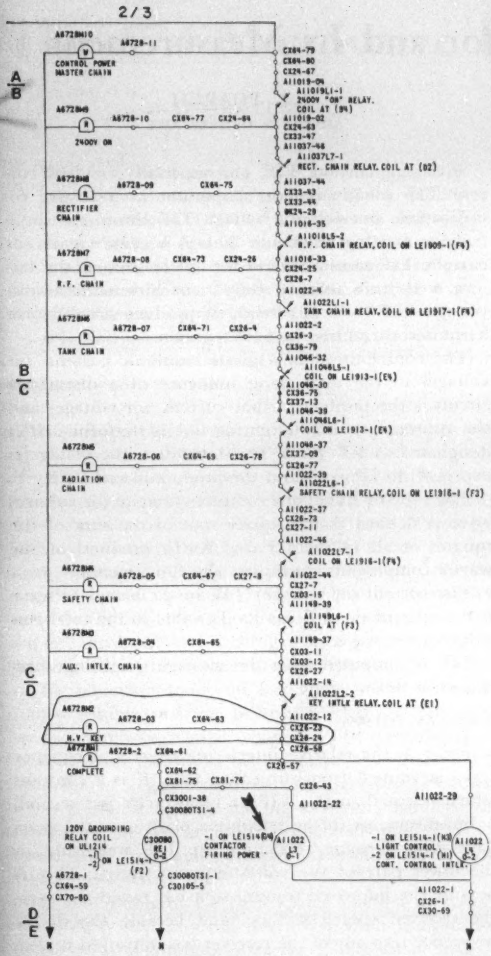


Fig. 16. Lawrence Radiation Laboratory diagram has standardized numbering scheme which indicates at a glance where the rack, panel, or terminal is to be found.

Explanation of numbering scheme

Number—A6728-11 (terminal in top line of diagram): (1) First letter (A) indicates area or multiple-rack group in which rack is located; (2) First two digits (67) indicate rack number; (3) Next group of two digits (28) indicates panel which occupies modular space 28 on the rack; (4) Number (11) after dash indicates 11th terminal on terminal strip of this panel (panel 28). (Terminal is counted from left end, facing rear of rack.)

to 12¼ inches in height and up to 36 inches in depth, with a wide variety of compartmentation, from a limited number of stock chassis components (front panels, brackets, and subchassis plates). The variety of chassis heights, depths and compartmentations attainable are illustrated in Fig. 14.

Certain circuit functional subdivisions, such as power supplies and regulators, which form the building blocks of a wide variety of different electronic instruments, are produced as standard subchassis units and kept in stock. Hence they can be built into a chassis (Fig. 15) by bolting the appropriate standard building block unit to the chassis. Also, certain types of switches, relays, and meters, which are frequently used in groups, are assembled on prefabricated panels which can be mounted on the rack as a single unit. The fabrication and wiring time saved by using such prefabricated stock units materially reduces the time required to construct a complete system.

NUMBERING SYSTEM

To round out and complete the whole standardization picture, a standardized numbering procedure has been adopted so that the number of a rack, panel, or wiring terminal indicates where the corresponding rack, panel, or terminal is located. Consequently, the installer or service man can tell, from its number on the wiring diagram, where a particular electronic unit or particular circuit connections can be found (Fig. 16). This has proved to be a tremendous time saver in installation and servicing.

To summarize, each of the complex electronic systems required for instrumentation of modern test and research facilities may constitute a highly specialized design and construction project. However, adherence to a few principles of design and construction standardization can contribute a great deal of flexibility to each such system and can materially reduce the time and cost of its construction. Furthermore, with the principles of design and construction standardization presented here as a nucleus, it is readily possible to evolve a standardization code for large-scale electronic instrumentation systems that would make the great financial and other benefits of standardization realizable in research facilities as well as in other areas of technology.

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Telephone Influence Factor and Its Measurement

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THE Joint Subcommittee on Development and Research, Edison Electric Institute and Bell System, has issued a 1960 weighting characteristic for telephone influence factor (TIF). This factor is dimensionless and provides an index of the inductive influence of a power system wave shape. Fig. 1 shows the new curve in comparison with its several predecessors.

Each curve was based upon the relative interfering effects (message weighting) of noises of various frequencies as determined from subjective tests with telephone instruments in use at the time, and upon the coupling between power and telephone circuits. The 1960 curve

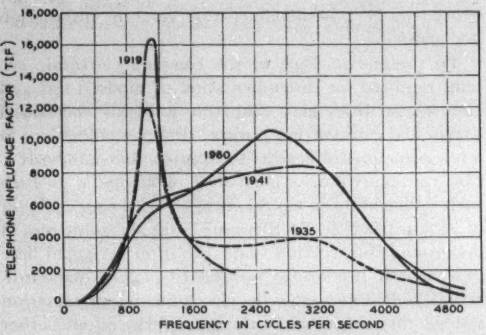

Fig. 1. TIF weighting curves, 1919-60.

is based upon the *500* type telephone set. It is felt that the response of these sets is such that the interfering effects are largely controlled by characteristics of hearing. It is unlikely that such changes as may be made in future types of telephones will require a re-evaluation of TIF.

The inductive influence of a power line is dependent upon the TIF and magnitude of the currents or voltages. Voltage TIF affects electric induction, which usually is a problem only with open-wire telephone lines. Current TIF is important in cases of magnetic induction. Except for very close separations, the induced voltage is essentially longitudinal and is caused chiefly by residual currents in the power line. Residual current is the vector sum of the phase currents, and its TIF may be quite different from that of the phase currents.

Digest of paper 60-1195, recommended by the AIEE Wire Communication Systems Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Fall General Meeting, Chicago, Ill., Oct. 9-14, 1960. Published in AIEE *Communication and Electronics*, Jan. 1961, pp. 659-64.

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Although current TIF, and especially residual current TIF usually is more important in inductive coordination, open-circuit voltage TIF limits are specified for rotating machines. This is because significant current TIF measurements are not feasible at the factory, and it is assumed that a machine with a low-voltage TIF will not tend to produce troublesome harmonic currents in a power system.

The contribution of a given harmonic current (or voltage) to the total noise influence of a disturbing circuit is the product of that current (or voltage) and the appropriate TIF weighting for its frequency. It is designated as I·T (or V·T). More often the voltage is expressed in kilovolts and the product is written Kv·T.

The I·T (or Kv·T) of a complete current (or voltage) wave is defined as the square root of the sum of the squares of all of the I·T (or Kv·T) products of the wave's components, including the fundamental.

The current (or voltage) TIF of the complete wave is the ratio of the I·T (or Kv·T) value to the total rms value of the wave.

TIF is computed from the message weighting characteristic thus:

$$\text{TIF}_f = K p_f \ (f/1{,}000)$$

where p_f is the relative interfering effect at frequency f as determined from subjective tests. K is a constant which is equal to the TIF at 1,000 cycles per second.

Improvements in the telephone plant over the years have allowed some relaxation in TIF weighting in the lower part of the voice-frequency range. This is because the improved transmission has raised the average received speech volume, and because the flatter frequency response of the receiver has improved understandability. Conversely, the TIF weighting in the upper part of the voice-frequency range has been raised because of the increased response of the receiver at these higher frequencies.

TIF can be computed from a harmonic analysis of a voltage or current wave. Less accurate but much more convenient single over-all measurements in accordance with the 1960 weighting can be made with the new Western Electric Company *3A* Noise Measuring Set and a suitable coupler which introduced a multiplier of f. The voltage coupler contains a capacitor in series with the set input and the current coupler an inductor in parallel with it. The set reading is proportional to V·T or I·T and, when multiplied by a constant and divided by the voltage or current, gives the TIF of the wave applied to the coupler. The couplers usually are used with instrument transformers. The accuracy of the networks in the *3A* set varies over the frequency range, averaging about ± 0.5 db, and the over-all accuracy of the set is about ± 1 db.

The *57A* Microwave Path Protection System

D. H. HESSELGRAVE

M. H. KEBBY
ASSOCIATE MEMBER AIEE

This is a fault-sensing and switching system serving as an automatic guardian of the quality of a broadband (1,300 kc) transmission channel. Acting upon a loss in transmission level or an increase in noise, it transfers a communication traffic load from a failing regular channel to a normally unassigned standby channel. Protection afforded by standby channel can be shared by three regular channels.

INTERRUPTION of radio transmission in the microwave spectrum may occur because of fading or because of equipment failure. To ensure continuity of transmission, a redundant path normally exists to take over an ailing primary path. Typically, this redundant path may be a parallel radio relay system, operating at some frequency removed from the regular system frequency. Signal loss by frequency-selective fading, the major reason for outage, can now be circumvented by switching service from the regular radio path to the redundant path, the standby system.

To achieve economy of frequency spectrum and of radio equipment, one protection channel can serve more than one regular channel. The probability of transmission continuity will depend of course on the number of regular channels sharing this protection service, the frequency spacing between channels, the length of the system and its associated number of exposures to fades and multipath transmission, and the equipment reliability.

The *57A* Microwave Path Protection System permits an orderly expansion of microwave path transmission capacity at a minimum expense. This system, with its maximum capacity of three regular channels for one protection channel, offers a saving in frequency spectrum and repeater cost over that of the typical frequency diversity, one-for-one protection system.

GENERAL DESCRIPTION

The system here described was created as a companion system to the *74A* 6-kmc Radio Relay System.

The protection system consists of three main units:

1. A sensing unit associated with the receiving end of each radio system, to determine quality of transmission.

2. A switching unit, to transfer the input and output baseband connections from the regular to a protection channel during regular channel failure.

3. A supervisory control path between the sensing unit at the receiving end and the switch elements at the transmitting end of the radio system.

This equipment protects a unilateral transmission path. Since most of the practical applications are on a bilateral transmission path, such as the telephone facilities between two cities, two sets of protection systems are combined in the typical installation. Common equipment, such as a regulated power supply and certain relay-rack mounting hardware is shared by the two systems. The equipment is now termed a "duplex terminal," wherein the transmitting end for one direction of transmission is grouped with the receiving end of the other transmission direction. Such a terminal, fully equipped, appears in Fig. 1.

SIMPLIFIED OPERATING DESCRIPTION

A SIMPLIFIED BLOCK DIAGRAM of this system appears in Fig. 2. Before entering into a detailed system description, let us consider briefly how the system operates. Under normal service conditions, the baseband inputs for the regular channels—typically, multichannel carrier systems—go through the transmitting switches on their way to the radio transmitter input. At the receiving end, these signals go through the receiving switches on their way to the receiving drop terminations. Normally, a fourth radio system, the standby channel, has both the input and output connections terminated, and is not carrying any service.

When a sensing circuit recognizes a failure of its associated regular channel, a command signal is sent to

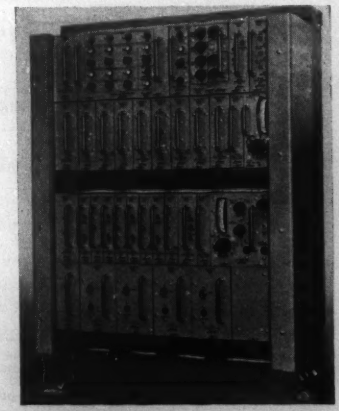


Fig. 1. Fully equipped duplex terminal (transmitting and receiving ends) of a *57A* protection system.

Essentially full text of paper 60-1207, "The 57A Microwave Path Protection System," recommended by the AIEE Radio Communication Systems Committee and approved by the AIEE Fall General Meeting, Chicago, Ill., Oct. 9-14, 1960. Published in AIEE *Communication and Electronics*, Jan. 1961, pp. 654-59.

D. H. Hesselgrave and M. H. Kebby are with Lenkurt Electric Company, Inc., San Carlos, Calif.

the transmitting end, the baseband input bridges to the standby channel, and the baseband signal now rides on two radio paths. When the receiving end of the switching system recognizes regular channel information on the standby channel, the receiving switches operate, and the baseband output connection for the regular channel is now transferred from the regular to the standby channel.

As soon as the regular channel recovers, the process reverses and the standby channel is again idle, awaiting another interruption to service.

Quite obviously, the above discussion omits mention of many of the vital functions required for the protection system to distinguish between a "good" and a "bad" channel, to decide which channel is to be switched, to prevent multiple or false switches, and to prevent any switches during the time that the standby channel is defective. With the background of the simplified system in mind, these points can now be examined. Fig. 3 serves as a guide for the following discussion.

SENSING CIRCUITS

FIRST, WHAT CONSTITUTES a "good" radio channel? This may be defined as one that has continuity from the baseband input to the baseband output at the far end, and one that has an over-all signal-to-noise ratio that is better than some arbitrarily chosen figure.

To establish continuity, the protection system monitors a pilot which is injected at the transmitting end of the system. This pilot lies above the commercially usable toll telephone baseband spectrum, at a frequency of about 1,600 kc. Its transmission level is a compromise between one that would be so high as to load the radio system, and one that is so low that the superimposed modulating tones could not be recovered in the presence of system noise. This compromise level is about 12 db below that of a single voice frequency (v-f) channel test tone, as applied from a 264-channel carrier system.

In order that the receiving end of the system can determine if the standby channel is connected to a regular channel input or is merely idle, only the regular channel pilots carry a superimposed 4-kc modulation; the presence of this modulating tone at the standby channel-sensing equipment signifies that a transmitting-end switch has been completed.

In addition to the pilot, the protection system also monitors the noise lying in a broad slot surrounding the pilot. Although this part of the radio baseband lies above the commercially-used spectrum, the noise characteristic is closely related to that within the commercial band; furthermore, the transmission roll-off is not of sufficient magnitude to alter the received signal level appreciably over normal length radio systems.

For ease in separating the pilot and the noise input

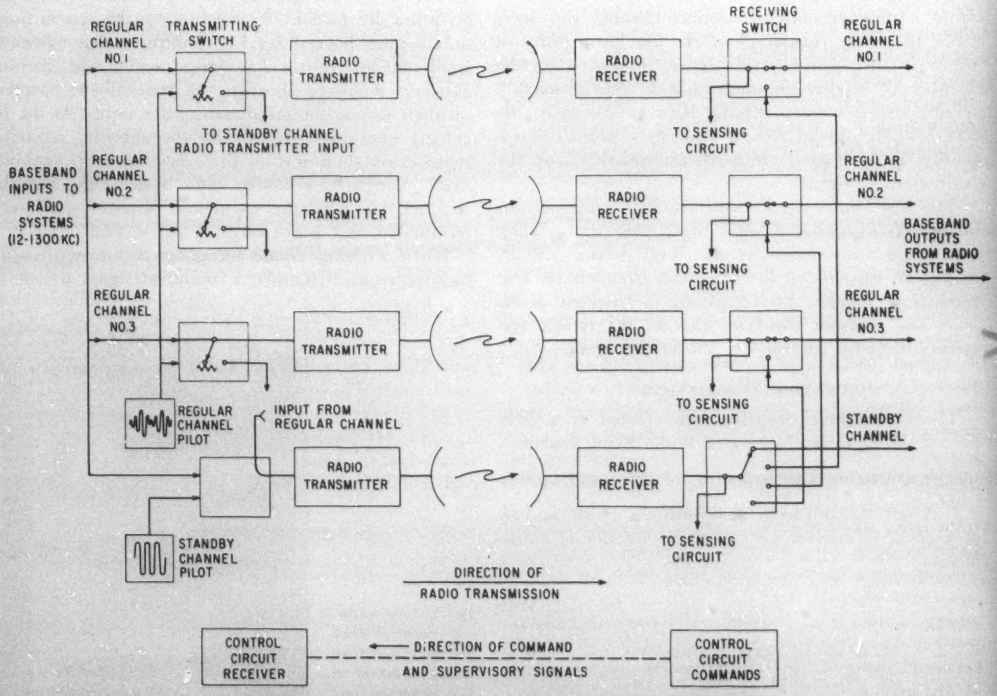


Fig. 2. Simplified block drawing of 57A Microwave Path Protection System.

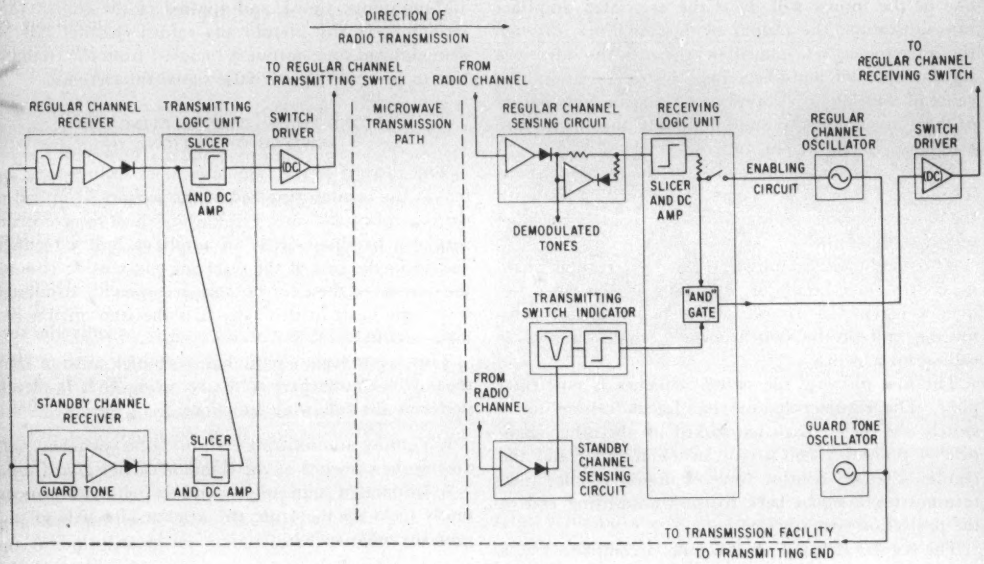


Fig. 3. Simplified drawing of control circuits for an automatic switch.

signals, and to prevent the pilot from being interpreted as a noise signal, the sensing equipment performs double-detection on the incoming signals. The entire signal is first amplified and then detected. The direct current due to this first detection (which is primarily the pilot signal) goes directly to a summing circuit; the modulation recovered from this detection is further amplified. This modulation must be split. The lower-frequency components, consisting of the guard and supervisory control tones, are directed to the appropriate control circuits. The higher-frequency components, lying in a band of about 30 to 100 kc on each side of the 1.57-mc pilot, are actually the system noise signals. This noise is further amplified, rectified, and then applied to the summing circuit.

The direct current due to pilot and that due to noise, as applied to the summing circuit, are mutually opposing. A drop in pilot level or an increase in noise level will trip a "slicer," or Schmitt trigger, to give an abrupt, discrete, control-voltage change. This change sets off the first event in the sequence leading to a complete protection switch.

The noise signals previously mentioned result either from radio transmitter failure or atmospheric fading. In either event, the gain of the radio receiver will rise, seeking an r-f signal. In doing this, it of course increases the baseband output level of the Johnson noise arising in the front end of the radio receiver. The system may be operated to switch the noise levels ranging between 20 dba (decibels adjusted) minimum to about 55 dba maximum. (As measured with a telephone-type noise measuring test set on the v-f drop referred to 0-db transmission-level point.) The pilot threshold is set so that a 3- to 4-db loss in pilot level will initiate a switch. In both the pilot and noise recognition circuits a fair degree of inertia or hysteresis must exist to prevent jittering between a switch and no-switch condition right at the threshold point.

FIRST PHASE—REQUEST FOR SWITCH PROTECTION

A DISCRETE VOLTAGE resulting from either low pilot or high noise is applied to the input of the receiving-end logic circuit. This circuit has three distinct functions:

1. It must initiate a transmitting-end switch request, but only if no other regular channel has already called for a protection switch.
2. It must order the completion of a receiving-end switch (the last event in the switch sequence), but only after the standby channel has bridged onto the regular channel at the transmitting end.
3. In the event of simultaneous failure of more than one channel and subsequent return to normal of a switched channel, it must delay the switch sequence to the second channel until the entire switch sequence from the first channel has been restored to normal.

At this stage of the switch sequence, only the first function is of importance.

The d-c output from each of the radio channel-sensing circuits is assigned to an input of the receiving logic circuit. These four inputs feed reverse-biased d-c amplifiers which, for the regular channels only, are interconnected. A request for switch protection on any

one of the inputs will drive the associated amplifier into saturation; the output of this amplifier, through the interconnection, immediately clamps the other two regular channel amplifiers in a cutoff condition. Because of the electrical "over-center" and bistable nature of these interconnected amplifiers, only one of the three can ever conduct at one time.

No order of preference exists for the regular inputs. They operate on a "first come, first served" basis, with the fastest sensing chain seizing the standby channel service.

The conducting amplifier turns on a regular channel-control tone oscillator, operating in the voice frequency region; its assigned frequency tells the transmitting end of the switch section which channel is calling for a switch.

The first phase of the switch sequence is now complete. The regular channel has failed, calling for a switch; the logic circuit has locked up the other channels to prevent a concurrent switch request; and the regular channel control tone oscillator is energized, transmitting a signal back to the transmitting end of the protection system.

The regular channel control tone, accompanied by a guard tone (for monitoring continuity of the control line) proceeds back to the transmitting end of the switch section via a common carrier facility. This may be a wire line paralleling the radio route for unidirectional radio systems. However, in the general case of the 2-way radio system, these control tones ride back as additional modulation on the protection system pilot for the opposite-direction radio system. It is important to recognize here that the *57A* Path Protection System has two functions: (1) that of maintaining system continuity by switching the failed channel to the standby channel when necessary; and (2) that of serving as a common carrier for the control tones of the complementary, opposite-direction-path protection system.

Since there is no more certainty of transmission continuity on this common-carrier path than there is on the forward-transmission path, the control tones are multipled to every radio channel for transmission back to the transmitting end. At the far end of the switch section, these tones are demodulated from the separate 1.57-mc pilots, added, and applied to the control-tone receiving circuits. Should any return channel fail, its demodulated tone output is removed from the common line to prevent noise or false signal interference.

Table I. Performance Characteristics of the *57A* Microwave Path Protection System

1. Baseband transmission frequency	12 kc to 1.3 mc
2. Pilot frequency	1.57 mc
3. Time required for a completed switch from the moment of failure	Approximately 125 ms
4. Level change during switch interval[1]	None
5. Transmission interruption during switch interval[1]	None
6. Insertion Loss (overall)	4 db
7. Power input: all channels normal	21 watts
8. Power input: maximum alarm and failure	60 watts

[1] This assumes a switch due to typical fade, or a relatively slow equipment failure. In either of these cases, full level baseband output must appear at the failing channel output from the moment that the failure is recognized until the switch is completed.

SECOND PHASE—TRANSMITTING-END SWITCH OPERATION

THE OUTPUT of the common-carrier control-tone system at the transmitting end of the section is applied to the control-circuit receivers. Each of these receivers consists of a bandpass filter, an amplifier, and a rectifier. Just as in the case of the receiving-end sensing circuits, the outputs of these control-tone receivers are connected to a logic unit; in this case, it is the transmitting-end logic circuit.

This latter logic circuit has a simpler mission than that of its counterpart at the receiving end. It merely performs the following functions:

1. Permits transmitting-end bridging switches only during the presence of the common-carrier guard tone.
2. Initiates a transmitting-end switch, and concurrently locks up the other two regular channels to prevent any other switch.

Because of the marked similarity in function between the receiving-end and the transmitting-end logic circuits, it was possible to use the receiving-end package, with a few components removed, at the transmitting end.

If the necessary conditions for a transmitting-end switch are fulfilled, a d-c output is delivered from the logic unit to an amplifier which drives a transmitting-end switching relay. This relay bridges the regular channel to the input of the standby channel. As a result of this switch, the standby pilot is removed and the regular channel pilot appears on the standby channel. The regular channel information now leaves the transmitting end of the switching system on two paths, that of its assigned channel and that of the standby channel. The second phase of the switching sequence is now complete.

FINAL PHASE—RECEIVING-END SWITCH OPERATION

THE APPEARANCE of regular channel pilot signal, with its accompanying 4-kc modulation on the standby channel, is the last "fact" necessary for the receiving logic circuit to order a receiving-end switch. The logic goes like this: a regular channel has failed, and the standby channel is bridged to a regular channel at the transmitting end—the failed channel output should now be transferred from the regular to the standby channel. Notice that the logic unit does not verify *which* regular channel has been bridged to the standby channel. In view of the lockout features at both the receiving and transmitting ends of the circuit, this refinement and additional safeguard is unnecessary.

The protection switch, as established in the preceding sequence, will hold until the regular channel is restored to a "good" condition again. At that time, the

entire switch sequence will progressively restore to normal.

SIGNAL SWITCHES

ALL BASEBAND SWITCHING is performed by quick-acting short-frame telephone-type relays with multiple-spring pile-ups. To reduce crosstalk between channels through the relay contacts, additional isolation is obtained by an arrangement of grounded relay springs.

The sequence of relay operations provides for the transfer of a failing channel to the standby channel with no level change or interruption of transmission during the switching interval.

OPERATING CONTROLS AND INDICATIONS

TO AVOID ANY AMBIGUITY, all control functions appear only at the receiving end of the section; each of these operating controls has an associated guard lamp to serve as a reminder of its operation. Two sets of controls are deemed necessary:

1. A control to lock-out, or disable, the automatic function of any one, or of all, the channels.
2. A control to switch manually any regular channel to the standby channel.

The guard lamps associated with these controls, along with a second set of indicator lamps, tell a complete story on the condition of the protection system. These lamps show which channels have failed and which are locked out; they also indicate that a switch sequence has completed, or that it failed to complete.

In addition to the receiving-end controls and indications, one set of indicator lamps is also located at the transmitting end of the switch section. These lamps show when a transmitting-end bridging switch has been made to a regular channel. The full set of lamps will indicate the steps in the switch sequence as just outlined to simplify trouble-shooting.

INTEGRAL TEST EQUIPMENT

A BUILT-IN METERING PANEL at the transmitting and at the receiving end of the system reads more than 30 different d-c functions. The progress of the switch sequence can be traced, step by step, with the aid of these meters. Additionally, the receiving-end test set includes a pilot and noise generator to facilitate lineup procedure. The complete lineup and adjustment of the entire *57A* protection system is accomplished with the use of these integral test sets, supplemented by a high-frequency a-c vacuum-tube voltmeter. The use of the lockout controls, plus a "Test-Normal" switch at the receiving end, permits complete system lineup without disconnecting the *57A* system from the radio channels. Of course, during this lineup interval the automatic protection service is disabled.

ELECTRICAL AND MECHANICAL FEATURES

THE *57A* SYSTEM is completely transistorized, using 103 transistors and 88 diodes in the fully-equipped version. It operates from a —48-volt unregulated source, a voltage supply common to the typical telephone office. The entire system is built up on a modular series of 30 plug-in units occupying 4 shelves in a standard relay rack. With no change in common wiring, the system may be expanded from a one-for-one (one standby channel to protect one regular channel) up to a one-for-three system, by removing a few plug-in bypass units and plugging-in the regular equipped units.

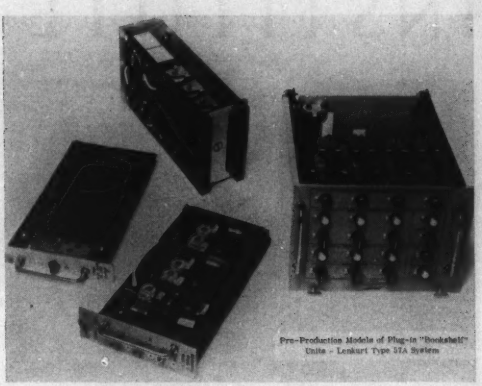


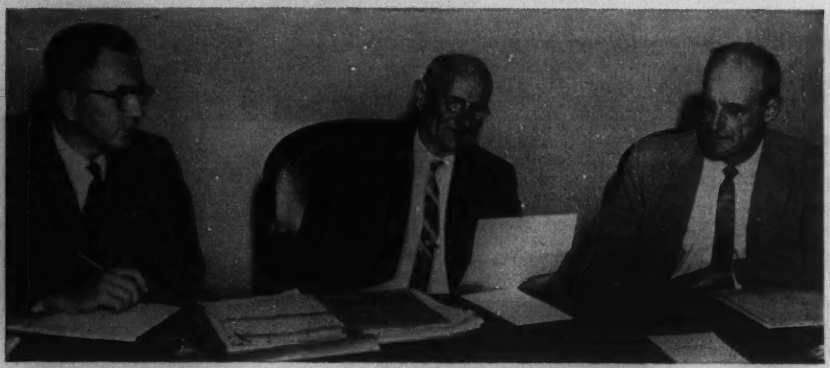
Fig. 4. Typical plug-in unit assembly and wiring.

Those units containing circuits common to all channels have an interlock jumper, which removes operating voltage from the system when units are unplugged. The removal (or the failure) of operating voltage causes all circuits to return to the normal, unswitched condition. A total of eight units—those carrying the switches at the transmitting and at the receiving ends —carry the transmission path and may not be unplugged without first patching out the channels affected. All other units may be removed with no risk other than having any automatic switch fall back to normal. The eight units contain only relays and passive elements, to minimize the necessity for their removal. For maintenance purposes, any unit can be extended out of the shelf, with both sides exposed, by interposing an extension unit. A set of parallel-connected bridging jacks at each end of the system permits either the patching out of a channel, or cross-patching of the carrier channels to different radio channels. These patches, which can parallel the normal path through the switch system, can be executed with no breaks or outages.

All units are wired following the Lenkurt-developed stitched-wiring process. This process, adaptable to any circuit consisting of components assembled on a flat dielectric mounting sheet, uses machine-driven staples on a grid pattern to support pigtail components. Wiring between components may be either by hand or on an automated basis. Fig. 4 illustrates the typical unit wiring.

The complete *57A* Microwave Path Protection System, shown in Fig. 1, occupies a total of 14 relay rack spaces (24.5 inches).

INSTITUTE ACTIVITIES



PLANNING the North Eastern District Meeting is the General Committee under the chairmanship of C. T. Hughes (*center*), retired vice-president of Connecticut Light & Power Company. The vice-chairman is C. L. Derrick (*right*), vice-president — engineering of Hartford Electric Light Company, and the secretary is J. M. Schamberger (*left*), electrical engineer, Connecticut Light & Power Company.

3-Day Technical Program Planned for AIEE North Eastern District Meeting

THE AIEE North Eastern District Meeting will take place at the Statler Hilton Hotel in Hartford, Conn., on May 17-19. Planning for this meeting has been under way for more than a year under the leadership of C. T. Hughes, retired vice-president of the Connecticut Light and Power Company.

The 3-day technical program will provide a thorough study of and a sounding board for many problems and ideas encountered by the electrical engineers within New England as well as numerous specific ideas and accomplishments of world-wide importance. Numerous papers pertaining to the fields of miniaturization and instrumentation, computers, power system engineering, distribution, transmission, relaying, space heating, insulated conductors, power generation, industrial power, communications, and industrial control will be presented.

Some of the subjects of the hundreds of papers to be presented are as follows: Instrumentation of Rocket Flights, Computer Solutions to Nuclear Ice Breaker Propulsion System Problems, Multi-Company Approach to Powercasting, Relaying Philosophy at Yankee Atomic Energy Plant in Massachusetts, Varnished Dacron Glass Insulated Cable, Direct Conversion of Energy—MHD, Continuous Process Furnace Anneal Stainless Steel, Touch Tone Dialing, and Industrial Digital Regulators.

Backing up the program subjects will be inspection trips to related plants and locations. A visit will be made to the Southern New England Telephone Company Microwave Center at Bloomfield. Another tour is scheduled to the extensively publicized building of the Connecticut General Insurance Company with its extraordinary electric equipment and unusual architecture. Trips to the Allen Set Screw Manufacturing Company and Pratt & Whitney in West Hartford will dramatize and illustrate the field of industrial control and advancement. A combined tour of the Combustion Engineering Company with its nuclear research facilities and Kaman Aircraft Company, maker of world-renowned helicopters, will give a vivid picture of the "horizons unlimited" theme of the meeting. A visit to the Connecticut Light and Power Company's dispatch center at Southington, housed in its nuclear explosion protected building, and observation of its computer control of generation, is expected to create interest on the part of all who visit it. The vast changes being brought about by urban redevelopment will be demonstrated by a tour around the New Haven redevelopment so widely publicized in the nation's newspapers.

A cocktail party, followed by a dinner-dance at the Statler Hilton on Thursday evening, May 18, an address by the Governor of the State of Connecticut at the luncheon on Wednesday, May 17, a social hour and smoker with some well-known entertainers on Wednesday evening, and an address by AIEE President C. H. Linder are some of the extra benefits already planned for those in attendance at the Hartford meeting.

The ladies' program will feature a Sage-Allen Fashion Show in the Terrace Room, a tour through the Connecticut General Insurance Company office building, and a lecture and film by Priscilla Hiers on her "Yankee Tour of the World."

HARTFORD, the insurance center of the world, will be host to the 1961 AIEE North Eastern District Meeting on May 17-19. Thirty-two insurance companies with headquarters or executive offices in Hartford, underwrite every known form of insurance.

Travelers Insurance Co.

Joint District Meeting Will Take Place in New Orleans

The Joint District Meeting of South East District 4 and South Central District 13, scheduled for April 5-7 will be held at the Jung Hotel in New Orleans, La.

The theme of the meeting will be "Progress in the South in the 60's." A productive meeting is being planned with a number of papers which emphasize the future growth of this fast-growing region.

Registration for the meeting will begin at 8:30 a.m. Wednesday, April 5. Social events include a complimentary cocktail party on Wednesday evening for members and their guests and a dinner dance and cocktail party on Thursday, April 6.

A variety of inspection trips will be offered to the member-visitors to the fabled Crescent City.

Included are tours of the New Orleans Sewerage & Water Board facilities; the Louisiana Power & Light Company's fully-automatic "Little Gypsy" steam electric generating station at Ninemile Point, above New Orleans; Kaiser Aluminum & Chemical Corporation's aluminum reduction plant, the nation's largest, at Chalmette, La.; Jackson Brewing Company's brewery; Celotex Corporation's insulation products plant at Marrero, La.; Avondale Marine Ways Corporation's shipyards at Avondale, La.; American Sugar Refining Company's Chalmette refinery, and an inspection trip of the Port of New Orleans aboard the yacht "Good Neighbor" through the courtesy of the Board of Commissioners, Port of New Orleans.

Rooms have been set aside at the Jung Hotel, on Canal Street, for members and their guests. Letters of request for reservations, starting April 4, should be addressed to the hotel, with specific reference to the AIEE meeting.

Rooms have been allocated at the following rates:

Single Room	$8 to $10
Double Room	$12 to $14
Twin Bedroom	$13 to $16
Suites	$23 and up

All rooms have private baths and the rates quoted are subject to a 3% sales tax.

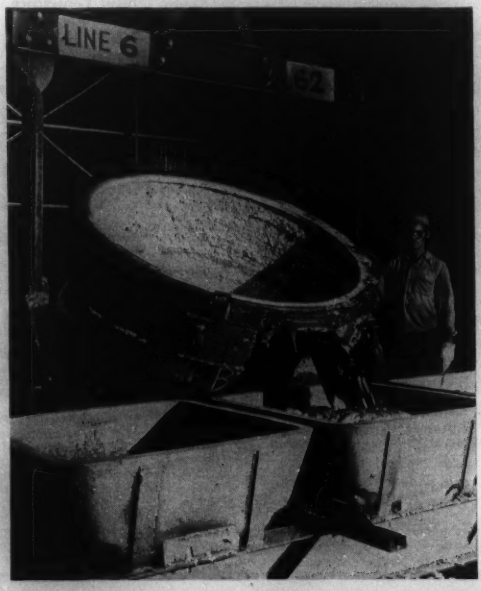
Highlights of the ladies entertainment program will include a walking tour through the historic Vieux Carre (French Quarter) and a visit to the Garden District.

The Joint District Meeting Committee includes J. R. Rombach, Jr., chairman; J. C. Ryan, vice-chairman and ladies activities; S. Cambias, Jr., secretary; M. L. Hurstell, assistant secretary, and E. I. Blanchard, treasurer. Committee chairmen are J. A. Cronvich, program; B. P. Babin, finance; P. A. Dimberg, registration; C. F. Dunn, entertainment; G. H. Kellermann, hotels; H. A. Schaeffer, Jr., inspection trips; R. J. Meyer, publicity, and G. W. Webb, students.

Minneapolis To Be Host City

Dick Magnuson

THE site of the AIEE Great Lakes District Meeting, to be held April 19-21, will be Minneapolis, Minn., at the Pick-Nicollet Hotel. This aerial view of Minneapolis, looking east across the 3rd Avenue Bridge, shows the skyline of the hub city of the Upper Midwest. The city provides an abundance of industrial, commercial, recreational, and cultural facilities.



MOLTEN aluminum metal pours from the giant crucible into molds to cast aluminum pigs weighing up to 1,000 pounds each at Kaiser Aluminum & Chemical Corporation's Chalmette, La., plant. The nation's largest aluminum reduction plant, it has a capacity of more than 495 million pounds of aluminum annually. This plant will be inspected by members attending the AIEE Joint District Meeting of South East District 4 and South Central District 13, scheduled for April 5-7.

Cal Pictures

Railroad Conference To Be Held in San Francisco

San Francisco, Calif., will be the host city to the 1961 Railroad Conference scheduled for April 20-21.

The technical program for the conference will highlight topics of current local and national interest, such as rapid-transit progress and diesel locomotive developments. Social events featuring prominent speakers will again be an important part of the total conference program.

The Sir Francis Drake Hotel will serve as conference headquarters.

The conference will be sponsored by the Railroad Division of the American Society of Mechanical Engineers and the Land Transportation Committee of the AIEE, with the co-operation of the San Francisco sections of each society.

AIEE Future Meetings

Winter General Meeting*
Hotel Statler
New York, N. Y.
January 29-February 3, 1961

AIEE-IRE-U of P International Solid-State Circuits Conference*
University of Pennsylvania
Philadelphia, Pa.
February 15-17, 1961

AIEE-IAS-IRE-U of P Engineering Aspects of Magnetohydrodynamics Symposium*
University of Pennsylvania
Philadelphia, Pa.
March 9-10, 1961

AIEE-ASME-II of T American Power Conference*
Sherman Hotel
Chicago, Ill.
March 21-23, 1961

South East District Meeting*
Jung Hotel
New Orleans, La.
April 5-7, 1961

Rubber and Plastics Industries Conference
Sheraton Hotel
Akron, Ohio
April 10-11, 1961
(Final date for †TP—closed, ‡CP Syn.—closed, CPMs—Feb. 3)

Materials Handling Conference[1]
Pick-Congress Hotel
Chicago, Ill.
April 11-12, 1961
(Final date for †TP—closed, ‡CP Syn.—Jan. 26, CPMs—Feb. 6)

Electric Heating Conference[1]
Sheraton-Lincoln Hotel
Indianapolis, Ind.
April 11-12, 1961
(Final date for †TP—closed, ‡CP Syn.—closed, CPMs—Feb. 6)

Extra High Voltage Cable Conference[1]
Mark Twain Hotel
Elmira, N. Y.
April 11-13, 1961
(Final date for †TP—closed, ‡CP Syn.—closed, CPMs—Feb. 6)

Cement Industry Conference
Sheraton-Cadillac Hotel
Detroit, Mich.
April 18-20, 1961
(Final date for †TP—closed, ‡CP Syn.—Feb. 2, CPMs—Feb. 13)

Great Lakes District Meeting
Hotel Pick-Nicolett
Minneapolis, Minn.
April 19-21, 1961
(Final date for †TP—closed, CPMs —Feb. 13)

AIEE-ASME Railroad Conference
Sir Francis Drake Hotel
San Francisco, Calif.
April 20-21, 1961
(Final date for †TP—closed, ‡CP Syn.—Feb. 3, CPMs—Feb. 14)

Joint Rural Electrification and Appliance Conference
Kentucky Hotel
Louisville, Ky.
May 1-3, 1961
(Final date for †TP—closed, ‡CP Syn.—Feb. 15, CPMs—Feb. 24)

AIEE-IRE-EIA-WCEMA Electronic Components Conference
Jack Tar Hotel
San Francisco, Calif.
May 2-4, 1961
(Final date for †TP—Feb. 2, ‡CP Syn.—Feb. 16, CPMs—Feb. 26)

Spring Textile Conference
Heart of Atlanta Motel
Atlanta, Ga.
May 4-5, 1961
(Final date for †TP—Feb. 3, ‡CP Syn.—Feb. 17, CPMs—Feb. 28)

AIEE-IRE-ACM Western Joint Computer Conference
Ambassador Hotel
Los Angeles, Calif.
May 9-11, 1961
(Final date for †TP—Feb. 8, ‡CP Syn.—Feb. 23, CPMs—Mar. 6)

Packaging Industry Conference
New Ocean House
Swampscott, Mass.
May 15-16, 1961
(Final date for †TP—Feb. 14, ‡CP Syn.—Feb. 28, CPMs—Mar. 10)

North Eastern District Meeting
Statler Hotel
Hartford, Conn.
May 17-19, 1961
(Final date for †TP—Feb. 16, CPMs —Mar. 13)

AIEE-IRE Globe-Communication V Conference[2]
Chicago, Ill.
May 22-24, 1961
(Final date for †TP—Feb. 21, ‡CP Syn.—Mar. 8, CPMs—Mar. 17)

AIEE-IRE-ISA-IAS-ARS National Telemetering Conference[2]
Sheraton Towers
Chicago, Ill.
May 22-24, 1961
(Final date for †TP—Feb. 21, ‡CP Syn.—Mar. 8, CPMs—Mar. 17)

Fractional Horsepower Motors Conference
Biltmore Hotel
Dayton, Ohio
May 23, 1961
(Final date for †TP—Feb. 22, ‡CP Syn.—Mar. 9, CPMs—Mar. 20)

Summer General Meeting
Cornell University
Ithaca, N. Y.
June 18-23, 1961
(Final date for †TP—Mar. 20, ‡CP Syn.—Mar. 30, CPMs—Apr. 14)

Pulp and Paper Conference
Kalamazoo, Mich.
June 21-23, 1961
(Final date for †TP—Mar. 23, ‡CP Syn.—Apr. 7, CPMs—Apr. 17)

Aero-Space Transportation Conference
Benjamin Franklin Hotel
Philadelphia, Pa.
June 26-30, 1961
(Final date for †TP—Mar. 28, ‡CP Syn.—Apr. 12, CPMs—Apr. 21)

AIEE-AIChE-ASME-IRE-ISA Joint Automatic Control Conference
University of Colorado
Boulder, Colo.
June 28-30, 1961
(Final date for †TP—Mar. 30, ‡CP Syn.—Apr. 14, CPMs—Apr. 24)

JECM&B-IFME International Conference on Medical Electronics
Waldorf-Astoria Hotel
New York, N. Y.
July 16-21, 1961
(Final date for †TP—Apr. 18, ‡CP Syn.—May 4, CPMs—May 15)

Pacific General Meeting
Hotel Utah
Salt Lake City, Utah
August 23-25, 1961
(Final date for †TP—May 25, ‡CP Syn.—June 5, CPMs—June 19)

AIEE-ASME Engineering Management Conference
Hotel Roosevelt
New York, N. Y.
September 14-15, 1961
(Final date for †TP—June 16, ‡CP Syn.—June 30, CPMs—July 11)

Fall General Meeting
Statler-Hilton Hotel
Detroit, Mich.
October 15-20, 1961
(Final date for †TP—June 14, ‡CP Syn.—July 27, CPMs—Aug. 11)

Winter General Meeting
Hotel Statler
New York, N. Y.
January 28-February 2, 1962
(Final date for †TP—Oct. 30, ‡CP Syn.—Nov. 9, CPMs—Nov. 24)

*Final date for submitting papers—closed
[1]No conflict in subject matter
[2]Planned to coincide

†TP—Transactions Paper
‡CP Syn.—Conference Synopsis
CPMs—Conference Manuscript
DPMs—District Manuscript
(District Paper Synopses should be directed to the District Meeting Committee)

Transactions and conference papers must conform to the requirements in *Author's Guide*. For a copy, write to E. C. Day, 33 W. 39th St., New York 18, N. Y.

Solid-State Circuits Conference To Be Held February 15-17 in Philadelphia

THE 1961 International Solid-State Circuits Conference will be held February 15-17 at the University of Pennsylvania and the Sheraton Hotel in Philadelphia, Pa.

Ten sessions, held at the university's Irvine Auditorium and the University Museum, will be devoted to the broad advances in the field of solid-state device applications and circuits. Forty-nine papers covering new device characteristics, microwave amplifiers and applications, logic, computer magnetics, power and control, storage, communication circuits and techniques, and new technologies will be offered. Invited papers on special topics also will be presented.

Eleven informal sessions, conducted by international leaders in the solid-state field, will be held on Wednesday and Thursday evenings in the Sheraton Hotel to provide registrants an opportunity to discuss the latest developments in the art. Among the topics on the agenda are tunnel diodes, micropower circuit operations, new logic techniques, reliability, microwave applications, power conversion, and controls. Additional subjects include low-frequency/low-signal amplification, microelectronics, high-frequency measurements and characterization, access and storage techniques, and solid-state optical masers.

Every registrant will receive a 116-page letterpress conference-report book featuring digests of every paper, supplemented by more than 300 illustrations. Post-conference copies of the report will be available at $5 each.

The tentative technical program follows:

Wednesday, February 15

9:00 a.m. Session I—New Device Characteristics—Irvine Auditorium

Chairman: E. O. Johnson, RCA

A Survey of Tunnel Diode Equivalent Circuits. *E. Baldinger*, University of Basel.

Efficiency and Linearity of Multicontact Hall Plates. *G. Arlt*, Philips Zentrallaboratorium.

An Analysis of Nonlinear Transmission Lines. *R. B. Riley*, Hewlett-Packard Co.

A Comparison of the Diffusion-Limited Semiconductor Diode and the Space-Charge-Limited Dielectric Diode. *G. T. Wright*, University of Birmingham.

Superconducting Tunneling Devices. *I. Gaever*, Research Laboratory, General Electric Co.

9:00 a.m. Session II—Microwave Amplifiers—University Museum

Chairman: E. W. Sard, Airborne Instruments Lab.

The Characteristics of an Esaki-Diode at Microwave Frequencies. *H. Fukui*, Sony Corp.

Some X-Band Microwave Tunnel-Diode Circuits. *R. Trambarulo*, Bell Telephone Labs.

Parametric Excitation and Amplification Using Esaki Diodes. *T. Yamamoto, A. Kishimoto*, Research and Development Center, Japan Defense Agency.

High-Frequency and High-Power Operation of Tunnel Diodes. *G. S. Kim, J. B. Hopkins*, Electronics Lab., General Electric Co.

Waveguide Parametric Amplifiers. *B. C. De Loach, Jr.*, Bell Telephone Labs.

12:00 noon. Lunch—University Museum

1:45 p.m. Formal Opening of Conference—Irvine Auditorium

Introductory Comments: T. R. Finch, Bell Telephone Labs., Inc., chairman of the conference

Welcoming Remarks: G. P. Harnwell, president, University of Pennsylvania

1960 Conference Awards: A. P. Stern, Electronics Lab., General Electric Co., chairman of 1960 Conference

Invited Address: J. G. Linvill, Stanford Electronics Labs., Stanford University, will speak on the topic, "How Can Solid-State Electronics Mature without Losing Its Youth?"

2:50 p.m. Session III—Logic I—Irvine Auditorium

Chairman: J. J. Suran, Electronics Lab., General Electric Co.

Parametron and Tunnel Diode Progress in Japan. *E. Goto*, University of Tokyo

The Neuristor. *H. D. Crane*, Stanford Research Institute

Gain and Geometrical Considerations in Planar Optoelectronic Circuits. *T. E. Bray*, Electronics Lab., General Electric Co.

Flow Table Logic. *J. A. O'Connell, E. J. Skiko, P. Low*, IBM

Hydraulic Counterparts of Electronic Logic Components as Possible New Elements for Control. *H. H. Glaettli*, IBM

3:00 p.m. Session IV—Power and Control—University Museum

Chairman: P. F. Pittman, Westinghouse Electric Co.

Calculation of Offset Voltage in Saturated Switches. *J. Gibbons*, Stanford University

A New D-C Differential Transistor Amplifier. *D. Hilbiber*, Fairchild Semiconductor Corp.

Improved Magnetic Voltage Stabilizer Employing Silicon-Controlled Rectifier. *E. W. Manteuffel*, Advanced Systems Lab., General Electric Co.

A Control Circuit for PNPN Regulated Rectifiers. *R. J. Healey*, Bell Telephone Labs., Inc.

Redundancy Techniques in Reliable Power Supply Design. *D. A. Paynter, V. P. Mathis*, Electronics Lab., General Electric Co.

8:00 p.m. Informal Discussion Sessions—Sheraton Hotel

High Frequency Measurements and Characterization of Transistors.
Moderator: A. K. Rapp, Philco Corp.
Panel Members: M. M. McWhorter, Stanford University; V. H. Grinich, Fairchild Semiconductor Corp.; V. R. Saari, Bell Telephone Labs., Inc.; Y. C. Hwang, Electronics Lab., General Electric Co.; R. P. Abraham, Texas Instruments, Inc.; E. J. Rymaszewski, IBM.

Microwave Applications.
Moderator: R. M. Ryder, Bell Telephone Labs.
Panel Members: M. E. Hines, Microwave Assoc., Inc.; B. C. De Loach, Bell Telephone Labs.; F. R. Abrams, Airborne Instruments Labs.; E. Baldinger, University of Basel; J. H. Forster, Bell Telephone Labs.; E. Stern, Electronics Lab., General Electric Co.; and K. K. N. Chang, RCA

Micro-Power Circuit Operation.
Moderator: R. L. Trent, Fairchild Semiconductor Corp.
Panel Members: C. D. Simmons, Philco Corp.; R. D. Lohman, RCA; G. Saltus, Bell Telephone Labs.; R. Shultz, Fairchild Semiconductor Corp.; R. H. Baker, MIT Lincoln Labs., Lexington, Mass., R. A. Henle, IBM, Poughkeepsie, N. Y.

New Logic Techniques.
Moderator: E. Stabler, Electronics Lab., General Electric Co.

Conference Papers Open for Discussion

Conference papers listed below have been accepted by AIEE *Transactions* and are now open for written discussion until February 27. Duplicate double-spaced typewritten copies of each discussion should be sent to E. C. Day, Assistant Secretary for Technical Papers. AIEE, 33 W. 39th St., New York 18, N. Y., on or before February 27.

60-805 **Analog and Threshold Building Blocks for Variable-Radix Adders and Other Logic Networks.** *J. Sklansky*

60-1012 **Optimum Diameter, Spacing, and Burial Depth of Ground Grid Conductor.** *R. F. Stevens*

60-1236 **Line Entrance Gaps for Protection of Substation Insulation.** *T. F. Watson, Jr., R. Hiatt*

60-1247 **Coaxial Cable for Protective Relaying Communications.** *J. R. Linders*

60-1274 **Protection of Multiterminal and Tapped Lines.** AIEE Committee Report

Preprints may be purchased at 50¢ each to members, $1.00 to nonmembers, if accompanied by remittance or coupons. Please order by number and send remittance to: AIEE Order Department, 33 W. 39th St., New York 18, N. Y.

Panel Members: H. D. Crane, Stanford Research Institute; U. F. Gianola, Bell Telephone Labs.; W. W. Davis, Remington Rand Univac; S. Einhorn, Burroughs Corp.; M. H. Lewin, RCA Labs.; E. Goto, University of Tokyo; M. K. Haynes, IBM; G. B. Chaplin, Plessey Co., Ltd.; J. A. O'Connell, IBM.

Reliability.
Moderator: B. T. Howard, Bell Telephone Labs.
Panel Members: E. R. Kretzmer, Bell Telephone Labs.; R. R. Painter, RCA; J. W. Tarzwell, Autonetics Div., North American Aviation, Inc.; K. G. Ashar, IBM; C. H. Zierdt, General Electric Co.

Power Conversion and Control.
Moderator: L. Bright, Westinghouse Electric Corp.
Panel Members: D. Paynter, Electronics Lab., General Electric Co.; R. P. Putkovich, Westinghouse Electric Co.; H. Storm, General Engineering Laboratory, General Electric Co.; A. Walker, Westinghouse Manufacturing Co.

Thursday, February 16

9:00 a.m. Session V—New Technologies—Irvine Auditorium

Chairman: J. M. Early, Bell Telephone Labs.

Problems of Microminiaturization. *G. Mollenstedt, R. Speidel,* University of Tübingen

Progress Report on Thin Film Circuitry. *R. G. Counihan,* IBM Federal Systems Div.

Investigation of a Thin-Film Thermal Transducer. *J. G. Gottling,* MIT

Properties and Applications of Diffused Silicon Transistors Using Epitaxial Techniques. *W. B. Cagle, H. J. Patterson, H. E. Talley,* Bell Telephone Labs.

KMC Planar Transistors in Microwatt Logic Circuitry. *D. F. Allison, R. H. Beeson, R. M. Shultz,* Fairchild Semiconductor Corp.

9:00 a.m. Session VI—Computer Magnetics—University Museum

Chairman: R. H. Baker, MIT Lincoln Labs.

The Application of Domain Wall Motion to Storage Devices. *H. Rubinstein, T. L. McCormack, H. W. Fuller,* Laboratory for Electronics, Inc.

A Study of Switching in Thin Magnetic Films. *W. Dietrich, W. E. Proebster,* IBM

AC and Impulse Switching Techniques for Fixed Random Access, and Analog Memory Use. *R. E. McMahon,* MIT Lincoln Lab.

A Word-Organized Memory which Builds Address Decoding into the Topology of the Ferrite Sheet. *E. E. Newhall,* Bell Telephone Labs.

Circuit Approach for an All-Magnetic Computing System. *H. D. Crane, E. Van De Riet,* Stanford Research Institute

12:00 noon. Lunch—University Museum

1:30 p.m. Session VII—Logic II—Irvine Auditorium

Chairman: G. B. Chaplin, Plessey Co., Ltd.

100-Mc Nonsynchronous Computer Circuitry Using Esaki Diodes. *J. R. Turnbull, Jr.,* IBM

High-Speed Switching Circuitry Using Tunnel Diodes. *W. V. Harrison, R. S. Foote,* Texas Instruments, Inc.

Rapid-Transfer Principles for Transistor Switching Circuits. *A. K. Rapp, J. L. Robinson,* Research Division, Philco Co.

Determination of the Switching Speeds of Transistors by Stored Charge and Effective Life Time. *Y. C. Hwang, D. S. Clewerley, D. J. Monsour,* Semiconductor Products Dept., General Electric Co.

Fun for All Foreseen at Low Cost Summer Meeting

It has only happened once before in the last quarter of a century: an AIEE Summer Meeting held at an Ivy League school rather than at a summer-resort hotel. Come this June, father can take the whole family to the Summer Meeting for less, perhaps, than it would cost him to go alone to Atlantic City or Swampscott. Next June's big meeting also offers a grand opportunity for combining engineering business with a lot of summer activities that can be enjoyed by the whole family—motoring through some of the most scenic parts of this country, boating, hiking, and fishing. At the same time, the head of the family can relive his old school days.

The Summer General Meeting of AIEE has been scheduled for June 18-23 at Cornell University, far above Cayuga's waters at Ithaca, N. Y., a garden spot if ever there was one. Cornell lies in the famed Finger Lake country in the Empire State, next to those famed bodies of water; a short drive leads to many of New York's most beautiful towns and scenic spots. Bath, Ithaca, and other nearby towns are in the heart of the famed New York State wine country. Less than a half day's drive away is one of the wonderlands of the East—Letchworth State Park, a few miles south of Rochester on the Genesee River. At this point, the river cuts deep gorges and plunges over a steep cliff to create a miniature Niagara Falls.

All this and a big electrical engineering meeting too! Now's the time to plan to spend a week or more at Cornell and in the Finger Lake Country next June.

Continuous Phase Regenerative Logic. *W. F. Chow,* Sperry-Rand Corp.; *W. Peil, H. Raillard, R. Marolf,* Electronics Lab., General Electric Co.

1:30 pm. Session VIII—Microwave Applications—University Museum

Chairman: A. Uhlir, Jr., Microwave Associates, Inc.

PIN Diodes for Protective Limiter Applications. *D. Leenov, J. H. Forster,* Bell Telephone Labs., Inc.; *N. G. Cranna,* CBS Elec.

Low-Level Garnet Limiters. *M. Grace, F. R. Arams, S. Okwit,* Airborne Instruments Lab.

Microwave Tunnel Diode Autodyne Receiver. *F. Sterzer, A. Presser, A. H. Solomon,* Electron Tube Div., RCA

A New Broadband Absorption Modulator for Rapid Switching of Microwave Power. *F. Reggia,* Diamond Ordnance Fuze Labs.

Fast 1-Kilomegacycle Ferrite Switch. *E. Stern, R. E. Cole,* Electronics Lab., General Electric Co.

8:00 p.m. Informal Discussion Sessions—Sheraton Hotel

Low-Frequency Low-Level Signal Amplification.
Moderator: W. Moore, Jr., Brown Instrument Division, Minneapolis-Honeywell Regulator Co.
Panel Members: D. B. Hall, Texas Instruments, Inc.; J. S. MacDougall, Raytheon Co.; D. A. Robinson, Airpax Electronics, Inc.; E. G. Nielsen, Electronics Lab., General Electric Co.; D. Hilbiber, Fairchild Semiconductor Corp.; M. W. P. Standberg, Cambridge Electronics Corp.

A Second Look at Microelectronics.
Moderator: E. Fletcher, MIT
Panel Members: A. P. Stern, Electronics Lab., General Electric Co.; J. Nall, Fairchild Semiconductors Corp.; R. Alberts, WADD; T. Stanley, RCA Labs.; S. J. Angello, Westinghouse Electric Corp.; V. J. Kublian, Engineering Lab., U.S. Army Signal Corps; R. G. Counihan, IBM; W. Gaertner, CBS Labs., Inc.; E. Keonjian, American Bosh Arma Corp.; G. Mollenstedt, University of Tübingen.

Tunnel Diodes.
Moderator: E. O. Johnson, RCA
Panel Members: L. Cuccia, RCA; J. Tiemann, Research Laboratory, General Electric Co.; S. Sharpe, Bell Telephone Labs., Inc.; J. A. Walsh, IBM; J. R. Biard, Texas Instruments, Inc.

Access and Storage Techniques.
Moderator: A. Lo, IBM
Panel Members: J. E. Mack, Bell Telephone Labs., Inc.; S. M. Rubens, Sperry-Rand; M. Rosenberg, Telemeter Magnetics; E. A. Fisch, Electronics Lab., General Electric Co.; R. McMahon, MIT Lincoln Lab.; J. Rajchmann, RCA Labs.; Q. W. Simkins, IBM.

Optical Masers.
Moderator: A. L. Schawlow, Bell Telephone Labs.
Panel Members: R. T. Daly, Technical Research Group, Inc.; G. C. Dacey, Bell Telephone Labs., Inc.; M. Stevenson, IBM; G. Wessel, Electronics Lab., General Electric Co.; G. Birnbaum, Hughes Research Lab.

Friday, February 17

9:00 a.m. Session IX—Storage—University Museum

Chairman: R. A. Henle, IBM

A New Load-Sharing Matrix Switch. *N. G. Vogl, Jr.,* IBM

A 12-Kilobit 5-Microsecond Twistor Variable Store. *W. B. Gaunt, D. C. Weller,* Bell Telephone Labs., Inc.

An Evaporated Film 135—Cryotron Memory Plane. *J. P. Beesley,* Federal Systems Division, IBM

Coincident Current Superconductive Memory. *L. L. Burns, G. A. Alphonse, G. W. Leck,* RCA Labs.

High-Speed Tunnel Diode Memory. *D. L. Berry, E. A. Fisch,* Electronics Lab., General Electric Co.

9:00 a.m. Session X—Communication Circuits and Techniques—Irvine Auditorium

Chairman: R. L. Pritchard, Texas Instruments, Inc.

Optical Masers. *G. C. Dacey,* Bell Telephone Labs., Inc.

Wide-Band Esaki Diode Amplifiers. *G. E. Sharpe,* Bell Telephone Labs., Inc.

High-Speed Analog-to-Digital Converter Utilizing Tunnel Diodes. *R. A. Kaenel,* Bell Telephone Laboratories, Inc.

Superregenerative Circuits Using Tunnel Diodes. *J. F. Bogusz, H. H. Schaffer,* Research Division, Philco Corp.

12:00 noon. Lunch—University Museum

Membership in the American Institute of Electrical Engineers, including a subscription to this publication, is open to most electrical engineers. Complete information as to the membership grade, qualifications, and fees may be obtained from Mr. N. S. Hibshman, Secretary, 33 West 39th Street, New York 18, N.Y.

Summer Meeting Headquarters Selected

WILLARD Straight Hall at Cornell University will be the headquarters for the AIEE Summer General Meeting, scheduled for June 18-23. This photo shows the entrance to the building.

Electrical Engineering Exposition Planned for January 29-February 2, 1962

ENGINEERS and scientists of the nation's electrical industries are planning the first national exposition to help them meet the challenges of an advancing modern America. Sponsored by the AIEE and to be known as the Electrical Engineering Exposition, the event will be held January 29 through February 2, 1962, in the New York Coliseum.

The announcement was made by N. S. Hibshman, AIEE executive secretary, who said the Exposition will be held in conjunction with the Institute's annual Winter General Meeting. The decision to hold the Exposition was made after a survey of the membership attending last year's Winter Meeting showed that more than 57% of the engineers and scientists definitely wanted exhibits of electrical products and services to supplement the technical sessions.

Efficient Communication Sought

"The speed with which our technology is developing," Mr. Hibshman said, "demands direct and efficient communication. Two engineers talking in specific terms about a machine or circuit element in the presence of the device, or working model of it, represent the ultimate in efficient communications. An Exposition by engineers for engineers is a supplement of great value to our Technical Sessions and papers."

Manufacturing and service firms in the electrical field should note that their participation in the Electrical Engineering Exposition has been suggested by the very people who use their products and services.

The Electrical Engineering Exposition will be developed exclusively for the nation's engineers and scientists engaged in the invention, design, application, installation, operation, and the maintenance of electrical products and services. At the Exposition they will have the opportunity to see manufacturers and suppliers demonstrate the many and varied products and services they have to offer the electrical field.

Technical Sessions Also Scheduled

Technical sessions held in conjunction with the Exposition will meet in the Coliseum and in the Hotel Statler, which will serve as the headquarters for the joint event.

Reber-Friel Co., a nationally known exhibit management firm, has been engaged to manage the Exposition. Floor plans and detailed information about the Electrical Engineering Exposition are now being prepared.

Firms wishing to receive information in advance, should contact the Reber-Friel Company at 117 S. 17th St., Philadelphia 3, Pa.

Officers Named for NEC To Take Place October 9-11

J. J. Gershon, director of the Resident School, De Vry Technical Institute, Chicago, Ill., has been elected president of the National Electronics conference (NEC) for 1961.

Other officers named for the 1961 NEC, which will be held in Chicago at the International Amphitheatre on October 9-11, are: Vice-president, J. H. Kogen, GPE Controls, Inc.; secretary, Dr. T. F. Jones, Jr., Purdue University; treasurer, R. J. Parent, University of Wisconsin; assistant treasurer, Dr. J. S. Aagaard, Northwestern University.

Mr. Gershon, past vice-president and long active in NEC activities, succeeds Dr. L. Von Tersch as president. He has been particularly active in national and regional IRE activities of the Institute of Radio Engineers (IRE) for which he served as chairman of the Chicago Section, IRE. Mr. Gershon resides with his wife and two sons in Chicago. He is active in professional societies and is a member of the National Society of Professional Engineers, Eta Kappa Nu, Tau Beta Pi, the American Society for Engineering Education, and the Instrument Society of America.

Re-elected as NEC chairman of the board is W. O. Swinyard, vice-president of Hazeltine Research, Inc. Mr. Swinyard is a past president of NEC and was a member of the original group responsible for the organization of the conference.

Committee chairmen appointed are: Arrangements, C. F. Valach, Amphenol-Borg Electronic Corp.; awards, Dr. M. E. Van

J. J. Gershon

W. O. Swinyard

Valkenburg, University of Illinois; exhibits, J. S. Powers, Bell & Howell; fellowship awards, Dr. D. S. Gage, Northwestern University; housing, R. R. Foley, Bell & Howell; industrial advisory, Dr. R. M. Soria, Amphenol-Borg Electronics Corp.; international activities, Prof. G. E. Anner, University of Illinois; planning, J. S. Johnson, Wayne State University; procedures, S. I. Cohn, Armour Research Foundation; *Proceedings*, J. L. Asmuth, University of Wisconsin; program, Dr. W. L. Firestone, Motorola, Inc.; registration, Dr. E. W. Ernst, University of Illinois; student activities, L. J. Murphy, Illinois Bell Telephone Company; trust advisory, R. R. Jenness, Northwestern University; and NEC party, H. M. Sachs, Armour Research Foundation.

More than 12,000 registrants and a record attendance and number of exhibitors are expected at the 17th Annual NEC.

The NEC is a nonprofit organization serving as a national forum for the presentation of authoritative technical papers on electronic research, development, and application. Sponsors include AIEE, the Illinois Institute of Technology; the Institute of Radio Engineers, Northwestern University, and the University of Illinois. Participants are the Electronic Industries Association, the Society of Motion Picture and Television Engineers, Iowa State University, Marquette University, Michigan State University, Purdue University, University of Michigan, University of Notre Dame, University of Wisconsin, and Wayne State University.

Combined Conferences Scheduled on Medical Electronics for July 16-21

THE 4th International Conference on Medical Electronics, combined with the 14th Annual Conference on Electrical Techniques in Medicine and Biology, will be held July 16-21 at the Waldorf-Astoria Hotel, New York, N. Y.

The 1961 International Conference follows three successful international meetings which were held in London and in Paris.

This conference, combined with the 14th Annual Conference on Electrical Techniques in Medicine and Biology, is sponsored by the Joint Executive Committee on Medicine and Biology of AIEE, the Institute of Radio Engineers (IRE), and the Instrument Society of America (ISA), under the auspices of the International Federation for Medical Electronics. It is organized by IRE through its Professional Group on Bio-Medical Electronics.

Discussion Topics Listed

A technical program is now in preparation by an international subcommittee under the chairmanship of Dr. H. P. Schwan of the University of Pennsylvania. The theme of the conference covers a broad scientific area common to the engineering, medical, and biological fields. Acceptable topics for discussion include: Models of biological systems, physiological monitoring, system analysis, electrical and radiation stimulation study, automation, instrumental diagnostic methods, data analysis techniques, physical-chemical procedures, etc. These subjects encompass such medical specialties as: Myo- and neurophysiology, cardiology, circulatory physiology, obstetrics, respiration, experimental psychology, clinical pathology, as well as engineering techniques such as microwaves, servo-systems analysis, transducers, computers, ultrasonics, telemetry, etc.

The program is now open to prospective contributors. An abstract of 300 words for preliminary review and a 50-word summary for inclusion in an Advance Program should be submitted before April 1.

It is planned to print a Conference Digest concerning 600- to 1,000-word digests of the presented communications, to be distributed to participants at the conference. Digests must be received by the Program Committee by May 15. Alternately, authors may elect to submit their digests for review in lieu of the 300-word abstract. In such cases this should be mailed, together with the 50-word summary, before April 1.

Abstracts and digests may be in English, French, German, or Russian. Prospective authors are requested to address all correspondence to: Dr. H. P. Schwan, program chairman, Moore School of Electrical Engineering, University of Pennsylvania, Philadelphia 4, Pa.

Technical Exhibit Featured

Another feature of the conference will be a large technical and scientific exhibit of the latest techniques and equipment in the medical electronic and electrical fields. Some examples of scientific instrumentation, diagnostic and therapeutic equipment, techniques and systems will be displayed, and methods will be demonstrated.

Other highlights will include a banquet, a ladies program, guided tours to scientific, educational, and industrial laboratories and institutions and other unique points of interest in the New York metropolitan area.

The Conference Committee includes: L. E. Flory, chairman, David Sarnoff Research Center, Princeton, N. J.; O. H. Schmitt, vice-chairman, University of Minnesota; J. T. Farrar, secretary-general, Veterans Administration Hospital, New York, N.Y.; C. Berkley, arrangements, Rockefeller Institute, New York, N. Y.; W. E. Tolles, publicity and liaison, Airborne Instruments Laboratory, Deer Park, L. I., N. Y.; C. G. Mayer, finance, RCA International, Westfield, N. J.; and Lewis Winner, conference manager, consultant, New York, N. Y. A host of representatives abroad are acting as co-ordinators of the conference interests in their respective countries.

Russian Educational System Studied

A PANEL DISCUSSION on the topic "Russia vs. the United States in Scientific and Engineering Education" was held at the December meeting of the Burlington, Vt., Technical Group, AIEE. Pictured are: (*left to right*) C. H. Ridgley Burlington Plant manager, General Electric Company, who spoke on how well this country's present educational system meets industry's needs; Dr. A. J. Holden, Jr., education commissioner, State of Vermont, who gave his observations of the Russian educational system made during his visit there, and E. R. McKee, dean of technology, University of Vermont, who discussed some of the primary challenges in education which must be faced to meet the needs of the future.

Symposium Scheduled on Magnetohydrodynamics

The 2nd Symposium on Engineering Aspects of Magnetohydrodynamics will be held at the University Museum, University of Pennsylvania, Philadelphia, Pa., on March 9-10. This symposium is being sponsored jointly by AIEE, the Institute of The Aeronautical Sciences Inc., the Institute of Radio Engineers, and the University of Pennsylvania.

The primary purpose of the symposium is to exchange information among related disciplines involving magnetohydrodynamics. It is assumed the participants will have some degree of competence in one or more of the broad areas of program coverage. No tutorial sessions or papers are planned.

The tentative program of papers to be presented is as follows:

Flight Applications Session

Some remarks concerning MHD applications to the re-entry problem. *R. X. Meyer*, Space Technology Labs.

Continuous duty DC accelerators. *W. Powers*, Avco-Everett Research Lab.

Experimental magnetogasdynamic engine for argon, nitrogen and air. *S. T. Demetriades*, Northrup Corp.

The design, fabrication and test of a pulsed pinch plasma engine for space propulsion applications. *J. Pearson, C. Cavalconte, W. Guman, I. Granet*, Republic Aviation Corp.

Experiments in steady-state high-density plasma acceleration. *A. F. Carter, G. P. Wood, A. P. Sabol, R. H. Weinstein*, NASA Langley Field Research Center

Heat transfer to cold electrodes in a flowing ionized gas. *J. S. Fay, W. T. Hogan*, Dept. of Mechanical Engineering, Massachusetts Institute of Technology

Power Conversion Session

MHD power research in the United Kingdom. *B. C. Lindley*, Parsons, Ltd.

Vortex generators. *C. P. Donaldson*, Aero Research Association of Princeton

MHD power studies. *V. Blackman*, MHD Research Corp.

Measurements of the electrical conductivity of flame gases seeded with alkali metals and application to MHD power plant designs. *Dibelius, Luebke, Mullaney*, General Electric Co.

An electrodeless MHD generator. *Bernstein, Fanucci, Fischbeck, Jarem, Kulsrud, Lessen and Ness*, Forrestal Research Center and RCA Labs.

Progress in MHD power generation. *Brogan, Kantrowitz, Rosa, Stekly*, Avco-Everett Research Lab.

Electrode boundary layers in direct current plasma accelerators. *J. L. Kerrebrock, F. E. Marble*, California Institute of Technology

Communications and Diagnostics Session

Space charge waves and plasma diagnostics. *A. W. Trivelpiece*, Electrical Engineering Department, University of California

Diagnostic measurements of a highly ionized, steady state plasma. *A. L. Gardner*, Lawrence Radiation Lab.

RF reradiation spectrum broadening of a monochromatically excited plasma sheet due to the random motion of plasma constituents. *S. Zivanovic*, Bendix

Plane magneto-acoustic wave propagation through a stratified medium. *Gen*, City College

Some effects of a nonlinear electrical conductivity on propagation of electromagnetic waves. *M. Epstein*, USC Engineering Center

Communicating through a magnetoplasma. *R. L. Phillips, R. G. DeLosh*, Bendix System Division

Fusion Session

Plasma and fusion reactors. *M. B. Gottlieb*, Project Matterhorn, Forrestal Research Center

Some aspects of economics for fusion reactors. *R. F. Post*, Lawrence Radiation Lab.

Thermonuclear power and super-conductivity. *R. G. Mills*, Project Matterhorn, Forrestal Research Center

The hollow cathode arc. *L. D. Smullin, W. D. Getty, A. Starr*, Massachusetts Institute of Technology

Magnetohydrodynamic shear heating. *M. C. Gourdine*, Plasmadyne Corp.

WJCC Schedules 10 Sessions for Meeting To Be Held in May

Ten sessions have been scheduled for the Western Joint Computer Conference (WJCC), Dr. W. F. Bauer, general chairman for the 9th annual meeting, has announced. The conference will be held May 9-11 at the Ambassador Hotel in Los Angeles, Calif.

Sessions will be held on information retrieval, pattern recognition, automata theory and neural models, problem solving and learning machines, automatic programming, modeling human mental processes, computers in control, simulation, computers in communications, and large computer systems.

According to Dr. C. T. Leondes, program chairman for the 1961 conference, papers will be presented by technical, business, academic, and industrial personnel to emphasize the conference theme, "Extending Man's Intellect."

The theme for the 1961 conference was chosen to feature the expanding potential of the use of computers in widely varying applications. Almost 100 firms will display computers, readers, calculators, data processing systems, and other computer components with exhibits keyed to the theme of the meeting.

More than 2,000 persons are expected to register for the meeting sponsored by the National Joint Computer Committee formed of representatives of AIEE, the Institute of Radio Engineers, and the Association for Computing Machinery.

AIEE Section Entertained at Lockbourne Air Force Base

The Strategic Air Command, Lockbourne Air Force Base, recently entertained the Columbus (Ohio) Section, AIEE.

A smorgasbord at the N.C.O. Club was followed by an inspection of the enemy counter measure equipment and of various of the Command's aircraft. These include the KC-97 and KC-135 tankers, the F-101 Voodoo fighter, and the RB-47 bomber.

Vancouver Section Honors Fellows

Graphic Industries Ltd.

A TESTIMONIAL dinner in honor of H. W. Smith and F. O. Wollaston on their election to the grade of Fellow was held by the Vancouver Section, B. C., Canada, on December 5 in the Grosvener Hotel. Both men received their awards for engineering work associated with the expansion of the B. C. electric power system. The presentation of the citations was made by H. Carlberg of Richmond, Calif., District 9 vice-president. Among the speakers who paid tribute to the recipients was Dr. T. I. Ingledew (M '41, F '51), who, as chief engineer of B. C. Electric and later as president of B. C. Engineering, had over-all direction of their work. Pictured are: *(left to right)* Mr. Carlberg, Mr. Wollaston, Mr. Smith, and M. E. Green, Vancouver Section chairman.

Code for Recruiting Practices Approved by AIEE

Foreword
by W. K. MacAdam, chairman
AIEE Professional Conduct Committee

ETHICAL responsibilities in the recruiting of engineering college graduates, both on the part of the prospective employer, as well as the engineering graduate, have been a matter of interest and action on the part of the American Society for Engineering Education (ASEE) for many years. Proposed recruiting codes have been produced and reviewed with other interested placement associations, business groups and engineering societies, including AIEE and the Engineering Council for Professional Development (ECPD).

In 1959, a compromise code was produced entitled "Recruiting Practices and Procedures—1959," which has had the approval of ASEE, ECPD, and the National Society of Professional Engineers. As noted in the ASEE Preamble, the College Placement Councils, Inc., has approved the code with the exception of Item 7.

Following publication and approval as noted, the AIEE Professional Conduct Committee approved the code in its meeting of October 10, 1960, and the Professional Development and Recognition Department in its meeting on October 12, 1960, requested publication in *Electrical Engineering*.

A preamble to the code and the code itself, as approved by AIEE, follows:

Preamble

Certain recruitment practices have developed from time to time, in the stress of competition for engineering graduates, which have not been consistent with professional standards. In 1948, a committee appointed by ASEE first studied this problem and published "Ethics of Interviewing Procedures" in 1949.

In 1956, accelerated competition for engineering graduates again occasioned some shortsighted recruitment practices. The ASEE Committee on Ethics decided to revise the 1949 publication. The Midwest College Placement Association (MCPA) also appointed a committee to study the problem, and as a majority of its membership was also affiliated with the ASEE, arrangements were made to review the MCPA committee recommendations.

The Committee on Ethics then published a revision titled "Recruiting Practices and Procedures" in April 1957. Several months later, the College Placement Council, Inc., and the Chamber of Commerce of the United States jointly issued a statement on "Principles and Practices of College Recruiting."

In September 1958, a "task force" representing the ASEE Committee on Ethics and the College Placement Council, Inc., met to resolve the differences between the two "codes." The 1959 revision of "Recruiting Practices and Procedures" which follows represents the combined efforts of the "task force" with the exception of item 7 under "Employer Responsibilities." This item contains greater detail about conditions of employment that are most important to engineering students. The ASEE Committee on Ethics believes this detail is essential to the implementation of the "General Principles" expressed in the "code" and consistent with the best interests of the engineering profession.

This statement of "Recruiting Practices and Procedures" has been endorsed by the ECPD Ethics Committee and constitutes a supplement to the ECPD Canons of Ethics. Its purpose is to aid in the development and maintenance of high ethical standards in the procedures of college recruiting and in the relations between the employing organizations, college authorities, and college students who are engaged therein.

Additional copies of this report may be obtained from: W. L. Collins, secretary, American Society for Engineering Education, University of Illinois, Urbana, Ill. The price is 10¢ per copy, $1.00 for 25, and $3.00 per hundred.

Recruiting Practices and Procedures—1959

General Principles

It is in the best interests of students, colleges and employers alike that the selection of careers be made in an objective atmosphere with complete understanding of all the facts.

Therefore, the recruiting of college students for employment by business, industry, government and education should be carried out by the employers, students and college authorities to serve best the following objectives:

1. To promote a wise and responsible choice of a career by the student for his own greatest satisfaction, minimum wasteful turnover and most fruitful long term investment of his talents for himself, for his employer and for society.

2. To strengthen in him a high standard of integrity and a concept of similar standards in the employing organizations of the country.

3. To develop in the student an attitude of personal responsibility for his own career and advancement in it, based on performance.

4. To minimize interference with the educational processes of the college and to encourage completion of the educational processes of the college and to encourage completion of the individual's plans for further education.

Practices and Procedures

Responsibilities of the Employer.

1. The employer should contact the Placement Office well in advance regarding desired interview dates, broad categories of employment expected to be available, college degrees, and other pertinent requirements. He should advise promptly any change in his original request or subsequent arrangements with the Placement Office.

2. The employer should provide suitable literature to give students a true and factual picture of the employing organization. This material should be supplied in sufficient quantities and well in advance of the interviewing date.

3. When both the parent organization and subsidiary or affiliated organization conduct interviews in the same college, the respective interviewers should explain clearly their missions and the connections, both to the Placement Office and to the students.

4. Not more than two and preferably only one interviewer representing an employer should appear for each interview schedule. Arrangements for more than two interviewers should be made in advance, and only for reasons considered adequate by the Placement Office.

5. The Placement or other appropriate officer of the college should be advised in advance of any plans for campus visits by the representatives of an employer, including alumni of the college, to acquaint faculty members or students with company employment activities or opportunities. Such representatives should exercise scrupulous care to avoid undue demands on the time of faculty members or students.

6. An employer who desires to contact an individual student at the time of his interview visit should communicate with the individual well in advance, with a notice to the Placement Office.

7. The interviewer should clearly explain to the Placement Office and students any special requirements such as the passing of tests, physical examinations, signing of patent agreements, or if his job is affected by any union contract.

8. The interviewer should be punctual. He should tell the Placement Office when he will arrive as well as his expected departure time. Every effort should be made to avoid last minute cancellations.

9. The interviewer should very carefully follow the interview time schedule agreed upon with the Placement Office.

10. As soon as possible following an interview, the employer should communicate with the student and the Placement Office concerning the outcome of the interview.

11. The employer should give the student reasonable time to consider his offer, and in no case should the student be pressured into making a decision concerning employment.

12. If the employer invites a student to visit his premises for further discussion of employment, the visit should be arranged to interfere as little as possible with class schedules. He should explain what expenses will be paid, how and when. Invitations for this purpose should be made only on an individual basis, and the employer should avoid elaborate entertaining or overselling.

13. The employer should not offer a student special payments, gifts, bonuses, or other inducements, nor should he compensate or favor a third party to prevail upon the student to accept an employment offer.

14. Employers should not raise offers already made except when such action can be clearly justified as sound industrial relations practice, such as, when an increase in hiring rate is required on an overall basis to reflect salary adjustments in the employing organization.

15. The employer should keep the Placement Office informed concerning his interest in particular students and his negotiations with them.

16. When a student has declined a job offer, the employer should accept that decision as final. If for any reason the employer wishes to re-establish contact with the student, he should do so only through the Placement Office.

17. The employer should engage each student who has accepted his offer except when failure to do so is the direct result of contingencies explained during the interview or unavoidable economic factors not foreseen when the offer was made.

Responsibilities of the College.

1. As part of its general obligation for the development of the student, the college should accept responsibility for stimulation of his thinking about his career objectives and for assistance in overcoming handicaps which may hinder his progress toward objectives appropriate for him. Competent counseling services should be provided for this purpose, available to individual students.

2. The Placement Office should inform employers concerning the number of students available for interview in the several curricula, and the dates of graduation. This information should be sent as soon as it is available.

3. The Placement Office should announce to students early in the school year which employers will interview students and when. The Placement Office should make revised announcements from time to time as may be necessary.

4. The Placement Office should make employment literature available to students and faculty.

5. When an employer is looking for graduates in several fields (e.g., engineering, psychology, physics), the Placement Office should issue announcements to all qualified students concerned, and, so far as practicable, should schedule interviews for those who express interest.

6. The Placement Office should not restrict the number of interviews per student, except as necessary to discourage indiscriminate "shopping."

7. The college should provide adequate space and facilities for quiet and private interviews.

8. The Placement Office should provide interviewers with available records of those students in whom they are interested.

9. The Placement Office should arrange for interviewers to meet faculty members who know students personally and can provide information about their work and qualifications.

10. The Placement officer and faculty members should counsel students but should not unduly influence them in the selection of jobs.

11. The Placement Office should make certain that students are acquainted with this statement of "Principles and Practices of College Recruiting."

Responsibilities of the Student.

1. In seeking company interviews, the student should recognize his responsibility to analyze his interests and abilities and consider carefully his career objective and appropriate ways of meeting it. He should read available literature and consult other sources for information about the employer and organize his thoughts in order that he may intelligently ask and answer questions.

2. The student should contact the Placement Office well in advance regarding desired interviews or cancellations.

3. The student should use care in filling out such forms as may be requested in preparation for interviews.

4. In his interviews, the student should recognize that he is representing his college, as well as himself, and should be punctual and thoroughly businesslike in his conduct.

5. The student should promptly acknowledge an invitation to visit an employer's premises. He should accept an invitation only when he is sincerely interested in exploring employment with that employer.

6. When a student is invited to visit an employer's premises at the employer's expense, he should include on his expense report only those costs which pertain to the trip. If he visits several employers on the same trip, costs should be prorated among them.

7. As soon as the student determines that he will not accept an offer, he should immediately notify the employer.

8. The student should not continue to present himself for interviews after he has accepted an employment offer.

9. Acceptance of an employment offer by the student should be made in good faith and with the sincere intention of honoring his employment commitment.

10. The student should keep the Placement Office advised concerning his employment negotiations in accordance with the policy of his Placement Officer.

Students Attend Section Meeting

MEETING JOINTLY with the Case and Fenn Student Branches, the Cleveland Section, AIEE, had as its subject "Space Power Systems" at the Section's November meeting. Student members were guests of the Section at a dinner which preceded the meeting. Among those present were: (*left to right*) J. L. Fuller, chairman of the Section Nominating Committee; H. Kaplan, acting chairman of the Fenn Student Branch; A. J. Hornfeck, Cleveland Section chairman; J. J. Unger, member of the Section Meetings and Papers Committee; and V. P. Kovacik, guest speaker, manager of preliminary design department, Thompson-Ramo-Wooldridge Company. Others who attended, but not shown in the photo, were: L. J. Shaffer, Cleveland Section vice-chairman who received his Fellow certificate at the meeting; L. Thompson, chairman of the Case Student Branch; J. K. Brousil, Case student member; and W. D. Masters, chairman of the Section Student Branch.

ECPD Accreditation Made at Fairleigh Dickinson University

Dr. Peter Sammartino, president of Fairleigh Dickinson University, has announced that the electrical engineering curriculum at the university has been approved by the Engineers' Council for Professional Development (ECPD).

Dr. V. L. Salerno, dean of the College of Science and Engineering, states that this accreditation by the Council is widely accepted by organizations such as the National Bureau of Engineering Registration, the National Council of State Boards of Engineering Examiners, by the professional engineering societies, and by several of the bureaus of the United States Government.

ECPD accreditation is nationally recognized in the sense that engineers who graduate under such curricula are usually eligible for acceptance into any schools giving graduate programs in engineering.

In the State of New Jersey in particular, such engineers are now qualified to take the Professional Engineering Licensing Examinations, part of which are given immediately after graduation and part after a prescribed number of years of high caliber professional engineering experience has been gained.

Construction of UEC Proceeds

GLASS and spandrelite enclose the first 10 floors of the United Engineering Center (UEC) as shown in this picture taken in early December. Stainless steel mullions extend 4 stories higher, and only 5 courses of limestone remain to be placed. With the recent settlement of strikes in the construction industry, threats of delay have been eliminated.

Wagner International

ECPD Guidance Committee Seeks To Attract Students to Engineering Studies

THE forward march of our technological progress and economic growth requires the services of ever larger numbers of engineers working in industry, education, Government, and private practice. The first step toward increasing the engineering population to meet future needs is to attract additional qualified high school students to the study of engineering. This objective is being carried out by the Guidance Committee of the Engineers Council for Professional Development (ECPD) through a network of state committees which work directly with the schools.

Each year, thousands of engineers from the ECPD State Committees visit high schools across the country to tell the students about engineering and the aptitudes and preparation required for a career in this field. Through special projects and meetings, vocational counselors, mathematics and science teachers, and parents of high school students are also told about engineering and the career opportunities the profession offers to qualified students. The help of more engineers is needed to further develop and expand the ECPD guidance program.

Engineers interested in guidance are therefore asked to join in the ECPD program, rather than in independent programs, in order that a unified approach to the schools may be maintained.

The ECPD State Committees arouse interest in engineering through a variety of programs which include talks and panel presentations, the showing of films on engineering, inspection trips, promotion of high school engineering clubs and science fairs, television and radio programs, individual counseling, and many other activities. Use is made of National Engineers' Week by many committees as a focal point for special guidance projects.

The ECPD National Guidance Committee supports the work of the State Committees through two annual mailings to the nation's 30,000 high schools. The mailings provide the principals and counselors with literature on engineering and include a form which can be used to request guidance assistance from the ECPD State Committees.

Further expansion of guidance programs is limited only by the number of engineers interested in participating. Thousands of engineers are already giving unstintingly of their time to this activity. The help of still more engineers is needed. Members of engineering societies who would like to engage in engineering guidance work should first check to see what their local groups may already be doing in this field. Many local groups carry out special projects in co-operation with the program of their State ECPD Guidance Committee. Some engineers may prefer to volunteer their services as a speaker directly to the ECPD chairman for their state. A roster of the regional and state chairmen for the ECPD Regional Guidance Committees during 1960-61 follows:

Region I

Chairman—R. H. Stockard, director of placement, University of Rhode Island, Kingston, R. I.

Connecticut—W. H. Austin, William H. Austin & Associates, 114 S. Main St., Box 343, Cheshire, Conn.

Maine—W. S. Evans, dean, School of Engineering, University of Maine, Orono, Me.

Massachusetts—R. T. Bogan, Monsanto Chemical Company, Springfield 2, Mass.

New Hampshire—R. N. Faiman, dean, College of Technology, University of New Hampshire, Durham, N. H.

Rhode Island—John Kowalik, Narragansett Electric Company, 280 Melrose St., Providence 1, R. I.

Vermont—E. R. McKee, dean, College of Technology, University of Vermont, Burlington, Vt.

Region II

Chairman—Prof. H. F. Roemmele, placement officer & director of alumni relations, Cooper Union, New York 3, N. Y.

New Jersey—A. L. Huber, Jersey City Welding & Machine Works, 400 Grand St., Jersey City, N. J.

New York, Metropolitan—C. W. Miller, Room 1341-S, 4 Irving Place, New York 3, N. Y.

New York, Upstate—E. A. Hilbert, General Electric Company, General Engineering Laboratory, Building 5, Room 157, Schenectady, N. Y.

Region III

Chairman—D. M. Seeley, Executive Assistant-Engineering, U. S. Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pa.

Delaware—T. F. Degnan, E. I. duPont de-Nemours & Company, Louviers Building, Wilmington 98, Del.

District of Columbia—J. H. Broome, Minneapolis Honeywell Regulator Company, 4926 Wisconsin Ave., N.W., Washington 16, D. C.

Maryland—J. B. Gillett, Whitman, Requardt & Associates, 1304 St. Paul St., Baltimore 2, Md.

Pennsylvania—G. M. Colburn, Engineering Division, U. S. Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pa.

Region IV

Chairman—Prof. J. C. Reed, head, department of mechanical engineering, University of Florida, Gainesville, Fla.

Alabama—J. R. Cudworth, dean, College of Engineering, Box 1968, University, Ala.

Florida—Herbert McClammy, consulting engineer, 68 Ortegas Station, Jacksonville 10, Fla.

Georgia—Dr. R. T. Staton, assistant dean of engineering, Georgia Institute of Technology, Atlanta 13, Ga.

Mississippi—F. H. Kellogg, dean, School of Engineering, University of Mississippi, University, Miss.

North Carolina—Prof. J. K. Whitfield, North Carolina State College, Raleigh, N. C.

South Carolina—Dr. H. von N. Flinsch, head, Department of Civil Engineering, University of South Carolina, Columbia, S. C.

Tennessee—Prof. J. M. Henderson, director,

School of Engineering, Tennessee Polytechnic Institute, Cookeville, Tenn.

Virginia—L. R. Quarles, dean, School of Engineering, University of Virginia, Charlottesville, Va.

Region V

Chairman—G. P. O'Connell, assistant manager, Educational Relations, General Motors Corporation, 3044 W. Grand Blvd., Detroit 2, Mich.

Indiana—C. W. Kronmiller, manager, General Purpose Trans. Engineering Subsection, General Electric Company, 1635 Broadway, Fort Wayne, Ind.

Kentucky—R. E. Shaver, dean, College of Engineering, University of Kentucky, Lexington, Ky.

Michigan—Glenn Coley, Engineering Society of Detroit, 100 Farnsworth, Detroit 2, Mich.

Ohio—R. P. Stock, B. F. Goodrich Company, Akron 18, Ohio

West Virginia—R. B. Johnston, P. O. Box 249, Charleston 21, W. Va.

Region VI

Chairman—A. B. Drought, dean, engineering department, Marquette University, 1515 W. Wisconsin Ave., Milwaukee 3, Wis.

Illinois—J. E. Harrington, 910 Lake Shore Dr., Chicago 11, Ill.

Iowa—Prof. H. M. Black, Iowa State University, Ames, Iowa

Minnesota—W. W. Davis, Box 63, Route 2, Excelsior, Minn.

Missouri—W. E. Bryan, secretary, Engineers Club of St. Louis, 4229 Lindell Blvd., St. Louis 8, Mo.

Nebraska—Merk Hobson, dean, College of Engineering, University of Nebraska, Lincoln, Nebr.

North Dakota—F. C. Mirgain, North Dakota State College, Fargo, N. Dak.

South Dakota—M. L. Manning, dean, School of Engineering, South Dakota State College, Brookings, S. Dak.

Wisconsin—W. G. Murphy, College of Engineering, Marquette University, 1515 W. Wisconsin Ave., Milwaukee 3, Wis.

Region VII

Chairman—Robert Matteson, California Research Corporation, Box 1627, Richmond, Calif.

Arizona—Americo Lazzari, consulting engineer, 4323 N. 14th Ave., Phoenix, Ariz.

California, Northern—D. O. Horning, College of Engineering, University of California, Berkeley, Calif.

California, Southern—A. M. Whistler, Fluor Corporation, 2500 S. Atlantic Blvd., Los Angeles 22, Calif.

Idaho—Prof. D. H. Moser, head, engineering department, Northern Idaho Junior College, Coeur d'Alene, Idaho

Montana—E. W. Schilling, dean, College of Engineering, Montana State College, Bozeman, Mont.

Nevada—H. B. Blodgett, dean, School of Engineering, University of Nevada, Reno, Nev.

Oregon—A. A. Osipovich, research and development engineer, BPA, 4305 S. E. Knapp St., Portland 6, Oreg.

Utah—G. K. Borg, head, department of civil engineering, University of Utah, Salt Lake City, Utah

Washington, Eastern—R. E. Landerholm, Wood & Landerholm, consulting engineers, 220 Hutton Bldg., Spokane 4, Wash.

Washington, Western—Prof. D. C. McNeese, general engineering department, University of Washington, Seattle 5, Wash.

Region VIII

Chairman—J. G. McGuire, assistant dean, School of Engineering, Texas A. & M. College, College Station, Texas

Arkansas—Prof. J. L. Imhoff, head, department of industrial engineering, University of Arkansas, Fayetteville, Ark.

Colorado—H. E. Prater, 2001 S. Madison St., Denver 10, Colo.

Kansas—K. E. Rose, head, department of mining & metallurgical engineering, University of Kansas, Lawrence, Kans.

Louisiana—Prof. W. H. Carter, 865 Dubois Dr., Baton Rouge 8, La.

New Mexico—M. A. Thomas, dean, College of Engineering, New Mexico State University, University Park, N. Mex.

Oklahoma—M. R. Lohmann, dean, College of Engineering, Oklahoma State University, Stillwater, Okla.

Texas—Col. T. C. Green, executive secretary, Texas State Board of Registration for Professional Engineers, 308 W. 15th St., Austin 1, Texas

Wyoming—Prof. R. A. Morgan, assistant dean, College of Engineering, University of Wyoming, Laramie, Wyo.

Outside Continental U. S.

Canada—Roger Lessard, Ecole Polytechnique, Montreal, Quebec

Alaska—Prof. Charles Sargent, dean of faculty, University of Alaska, University, Alaska

Hawaii—Prof. B. M. Harloe, College of Engineering, University of Hawaii, Honolulu 14, Hawaii

AIEE and IRE Boards of Directors Formally Extend Areas of Joint Collaboration

PROGRESS continues toward the full realization of the stated objectives of the Boards of Directors of the Institute of Radio Engineers (IRE) and AIEE formally to extend the areas of collaboration in the interests of greater efficiency in the service of the profession.

Reciprocal membership admission privileges have been established, and a Joint AIEE-IRE Standards Committee with broad authority has been organized. A joint committee, with special competence in engineering education, is at work on the problem of further co-ordinated services to students.

Such collaboration is not new in the relations of the two Institutes. Joint sponsorship of more than a dozen conferences and symposia annually, and the sharing of responsibility for more than 120 student branches have demonstrated a capacity to work together effectively.

AIEE members, at least those who read *Electrical Engineering*, have noted the latest developments in the 1960 issues of August, page 684; October, page 858 (B40.011e); December, page 1061; and January 1961, page 90. IRE members, all of whom doubtless read at least the excellent "Poles and Zeros" page of their *Proceedings*, conducted by Dr. Ferdinand Hamburger, Jr., himself an outstanding "collaborator" (IRE editor, AIEE Instrumentation Division chairman), have the story up to that date in the December 1960 issue, page 1949.

Membership Privileges

Reciprocal membership admission privileges as provided in the AIEE Bylaws, effective January 1, 1961, are as follows: "A member of the Institute of Radio Engineers, by virtue solely of his qualifications submitted to that Society, may join AIEE in an equivalent grade of membership, up to, but not including Fellow, without payment of entrance fee. The basic equivalent grades shall be understood to be as follows:

AIEE	IRE
Member	Senior Member
Associate Member	Member
Affiliate	Associate

By agreement between the AIEE Board of Examiners, Bartow Van Ness, chairman, and the IRE Admissions Committee, J. L. Sheldon, chairman, the practical result is that the applicant who is a member of one society need give neither references, nor his professional record, nor pay a fee when applying for membership in the equivalent grade in the other. Time and expense is thus saved for both the applicant and the society. The Fellow grade is, of course, not available by application in either society. (See *Electrical Engineering* January 1961, page 90)

Joint Standards Committee

The AIEE-IRE Joint Standards Committee, with five voting members from each Institute plus nonvoting chairman, vice-chairman, and staff, is empowered by the respective Boards "to approve, jointly in the names of the societies, such standards as it determines, on its own cognizance, are suitable for joint promulgation." The voting members of the committee, appointed by IRE Standards Committee Chairman C. H. Page, are M. W. Baldwin Jr., chief of delegation; J. G. Kreer Jr.; R. L. Pritchard; P. A. Redhead; and H. R. Terhune. AIEE Standards Committee Chairman J. P. Jordan named the following: H. P. Westman, chief of delegation; Hendley Blackmon; J. A. Goetz; G. E. Schall; and A. C. Sheckler.

Student Branches and Members

The student problem is a good deal more complex and not so readily solved by mere concurrence of the Boards of Directors of the two Institutes. The Branches are autonomous organizations subject also to the discipline of their colleges and universities. Joint Branches were readily accepted 10 years ago and have operated successfully and grown in favor since. Now the question is whether there are ways to consolidate and simplify the organization and the program. Working on that problem is a joint committee of which the AIEE contingent is headed by D. E. Garr, chairman of the AIEE Student Branches Committee. With

Mr. Garr are W. R. Grogan, S. R. Warren, Jr., and G. G. Wilson. Dr. J. D. Ryder, past-president of IRE, leads the IRE half of the committee. The other IRE members are J. F. Reintjes, T. F. Jones, and R. E. Nolte.

The present program of expansion of formal collaboration had its beginning in conversations between Pres. L. F. Hickernell of AIEE and Pres. D. G. Fink of IRE. These talks led to the appointment of a Task Group on which IRE was represented by Mr. Fink, Dr. Ryder, and Haraden Pratt. The AIEE delegation included W. S. Hill, G. H. Brown, E. I. Green, and L. C. Holmes. This Task Group developed the recommendations culminating in the membership and standards actions, and the setting up of the present committee on student affairs.

Akron District, NSPE Meets with Akron Section, AIEE

The Akron District, National Society of Professional Engineers (NSPE), met with the Akron Section, AIEE, on December 13 at the University Club of Akron, Ohio.

W. H. Chase, vice-president, District 14, AIEE, and H. T. Borton, NSPE director from Ohio and past president of the Ohio Society of Professional Engineers, addressed the meeting on the topic, "Organizing the Engineering Profession To Achieve Unity." Mr. Chase is a vice-president of Ohio Bell Telephone Company at Cleveland. He was the recipient of the 1960 "Engineer of the Week" award for his outstanding contribution to engineering and civic affairs in Northeastern Ohio. Mr Borton is president of the Osborn Engineering Company in Cleveland.

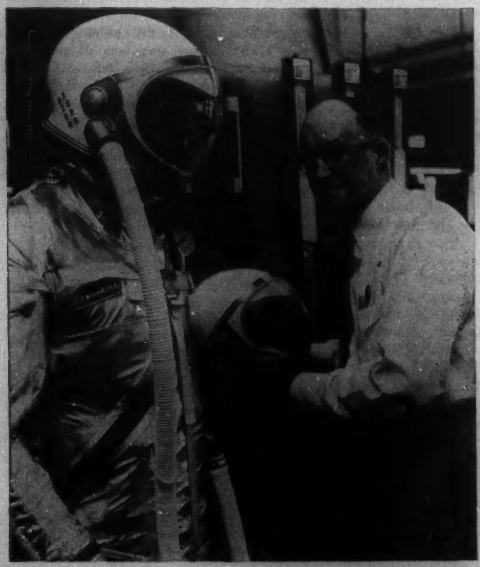
Fred Tambling Studio

A CERTIFICATE of appreciation was presented to E. L. Smith *(right)* of Akron by W. H. Chase *(left)*, AIEE vice-president, at the December 13 meeting of the Akron Section held in the University Club of Akron. E. F. Huston *(center)* presided. Mr. Smith, chief electrical engineer, Firestone Tire & Rubber Company, was honored for his past leadership as chairman of the AIEE Rubber and Plastics Industries Committee.

C. H. Fleming served as moderator for the Unity Talks. E. F. Huston, chairman of the Akron Section, presided at the meeting.

Prior to the talks, E. L. Smith, chief electrical engineer, Firestone Tire & Rubber Company, was presented a certificate of recognition and appreciation by Mr. Chase. Mr. Smith was honored for his past leadership as chairman of the AIEE Rubber and Plastics Industries Committee. The purpose of this committee is to stimulate and initiate engineering papers and to promote standards and recommend practices in the electrical engineering field of the rubber and plastics industries. In accepting the certificate, Mr. Smith pointed out that the open discussions and the stimulating exchange of information, ideas, and experiences in technical committee work with leading engineers in the industry bring great benefits to the individuals and their employers. He urged the younger members in the audience to take full advantage of any opportunities they may receive to participate actively in AIEE work.

D. A. Nordstrom, general manager, Oehler Steel Company, was presented a past president pin by Mr. Borton at the meeting for his services with the Akron District, NSPE.



SPACEMEN'S TAILOR R. S. Colley *(right)*, an engineer of the B. F. Goodrich Aviation Products Company, makes some adjustments on a developmental model of the suit that will make America's astronauts the best dressed men in space. Mr. Colley, who worked with globe-girdling aviator Wiley Post to create the world's first high-altitude pressure suit in 1934, is a leading authority on space suit design. B. F. Goodrich also makes high-altitude suits for the Navy and Air Force.

High-Altitude Flying Suits Studied at Akron Section Meeting

R. S. Colley of the B. F. Goodrich Aviation Products Company spoke on "Suiting Man for Space" at the November 8 meeting of the Akron Section, AIEE.

A recognized expert in his field, Mr. Colley discussed the history of high altitude flying suits from the first suit that he designed for Wiley Post in 1934 to the suits presently in production at his company for the Astronaut Program. He also considered the problems that must be overcome to design space suits.

Nominating Committee for 1961 Officers Named

The AIEE Nominating Committee* met in the Boston Room, Statler-Hilton Hotel, New York, N. Y., 9:00 a.m., January 30, 1961, during the Winter General Meeting of the Institute, to nominate candidates for AIEE offices to be voted upon by the membership in the Spring of 1961. Representatives receive travel allowance. Alternates are required to attend only if called upon to serve in place of their representative.

Members of the committee, as of December 1960, are as follows:

Representing the 15 Geographical Districts:

1. S. P. Bartles, Kodak Park Works, Bldg. 23, Eastman Kodak Co., Rochester 4, N. Y.
2. W. W. Middleton, Bell Telephone Co. of Pennsylvania, 210 Pine St., Harrisburg, Pa.
3. D. R. Zeissett, Central Hudson G & E Corp., South Road, Poughkeepsie, N. Y.
4. W. J. Seeley, Duke University, Durham, N. C.
5. S. N. Witts, Northern States Power Co., 15 S. 5th St., Minneapolis 2, Minn.
6. E. G. Blythe, Northwestern Bell Telephone Co., 4 Fl., Dodge St. Bldg., 100 S. 19th St., Omaha, Nebr.
7. Kenneth J. Poole, 2010 Wolfe St., Little Rock, Ark.
8. C. A. Wells, 2071 N. Altadena Drive, Altadena, Calif.
9. J. H. Steede, British Columbia Electric Co., Ltd., 970 Burrard St., Vancouver 1, B. C., Canada
10. Rene Dupuis, Quebec-Hydro Electric Commission, 107 Craig St. West, Montreal 1, Que., Canada
11. D. T. Michael, Cincinnati Gas & Electric Co., Box 960, Cincinnati, Ohio
12. D. C. Switzer, Hartford Electric Co., 266 Pearl St., P. O. Box 2370, Hartford, Conn.
13. W. C. Burnett, Southern Bell Telephone & Telegraph Co., Box 2662, Birmingham 2, Ala.
14. J. W. Rittenhouse, Hi-Voltage Equipment, Division of Joslyn Manufacturing & Supply Corp., 4000 E. 116th St., Cleveland 5, Ohio
15. W. P. Worley, Department of Electrical Engineering, A & M College of Texas, College Station, Texas

Alternates:

1. M. A. Baker, General Electric Co., 3001 E. Lake Road, Erie, Pa.
2. W. J. Ellenberger, 6419 Barnaby St. N. W., Washington 15, D. C.
3. R. M. Franklin, Sperry Gyroscope Co., Great Neck, N. Y.
4. Herman Wolf, Duke Power Co., Charlotte 1, N. C.
5. W. E. Keefe, General Electric Co., Box 26, Bettendorf, Iowa
6. Stanley Hasterlo, Jr., Omaha Public Power District, 932 Elec. Bldg., Omaha, Nebr.
7. *1st Alternate*—W. E. Shaffer, 1100 N. Ash, Little Rock, Ark. *2nd Alternate*—H. H. Davenport, 2924 Circlewood, Little Rock, Ark.
8. J. F. Sinnott, San Diego Gas & Electric Co., 861 Sixth Ave., San Diego, Calif.
9. L. N. Stone, Electrical Engineering Department, Oregon State College, Corvallis, Oreg.
10. G. F. Tracy, Electrical Engineering Department, University of Toronto, Toronto, Ont., Canada
11. J. J. Fredrickson, General Electric Co., 700 Antoinette St., Detroit 2, Mich.
12. R. W. Hunt, Public Service Co. of New Hampshire, 16 Central Square, Keene, N. H.
13. C. P. Knost, Moloney Electric Co., Box 13064, New Orleans 25, La.
14. F. E. Harrell, Skidmore Gear Co., Cleveland, Ohio
15. *1st Alternate*—E. H. Soderberg, Lower Colorado River Authority, Austin, Texas. *2nd Alternate*—Francisco Aubert, Apartado Postal 1599, Mexico City, Mexico

Representing the 6 Technical Divisions:

Communication—C. E. Dean, Hazeltine Research Corp., 5925 Little Neck Pkwy., Little Neck 62, N. Y.
General Applications—L. R. Larson, The Martin Co., P. O. Box 179, Denver 1, Colo.
Industry—J. F. Deffenbaugh, Federal Machine & Welder Co., 1745 Overland Ave., Warren, Ohio
Instrumentation — Ferdinand Hamburger, Johns Hopkins University, Baltimore 18, Md.
Power — J. H. Kinghorn, American Electric Power Service Corp., 2 Broadway, New York 8, N. Y.
Science & Electronics—E. L. Harder, Westinghouse Electric Corp., Advanced Systems Engineering & Analytical Department, E. Pittsburgh, Pa.

Alternates:

Communication—L. G. Abraham, Bell Telephone Laboratories, Inc., Murray Hill, N. J.
General Applications—G. E. Schall, Jr., Underwriters Labs., Inc., 161 6th Ave., New York 13, N. Y.
Industry—R. B. Moore, General Electric Co., 1 River Road, Schenectady 5, N. Y.
Instrumentation—Walter P. Wills, Minneapolis-Honeywell Regulator Co., Wayne & Windrim Aves., Philadelphia 44, Pa.
Power—C. A. Woodrow, General Electric Co., 1 River Road, Schenectady 5, N. Y.
Science & Electronics—H. W. Lord, General Electric Co., P. O. Box 1088, Schenectady, N. Y.

Representing the Board of Directors:

Hendley Blackmon, Westinghouse Central Labs., Beulah Rd., Churchill Boro, Pittsburgh 35, Pa.
R. B. Gear, Commonwealth Edison Co., 72 W. Adams St., Chicago 90, Ill.
C. T. Hatcher, Consolidated Edison Co. of N. Y., 4 Irving Place, New York 3, N. Y.
N. F. Rode, Electrical Engineering Dept., Texas A & M College, College Station, Texas
J. C. Strasbourger, Muncie Engineering Inc., 400 East Jackson St., Box 765, Muncie, Ind.
R. T. Weil, Jr., Manhattan College, Manhattan College Parkway, New York 71, N. Y.

Alternates:

F. H. Bacon, Jr., Box 312, Winchester, Mass.
J. H. Foote, Commonwealth Associates, Inc., 209 E. Washington Ave., Jackson, Mich.
E. I. Green, 95 Farley Road, Short Hills, N. J.
C. T. Pearce, Westinghouse Electric Corp., 3001 Walnut St., Philadelphia 4, Pa.
P. G. Wallace, Box 6331, Fidelity Union Life Bldg., Dallas 22, Texas

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See Constitution and Bylaws (*Organization Manual*, p. 156, pp. 164-65) and *Electrical Engineering*, November 1960 (p. 929).

Fellow Certificates Presented

Towne Studio Photos

NIAGARA Frontier Section, AIEE, featured the topic, "Organizing the Engineering Profession To Achieve Unity," at the Section's December 1 meeting. Prof. G. M. Reed, chairman of the School of Engineering, Clarkson College of Technology, spoke and conducted a lively question and answer period which followed his talk. At this meeting, certificates of Fellow membership were presented by Clair Gaylord (District 1 vice-president (*at left in both photos*), to S. F. Henderson (*left photo, at right*) and F. C. Rushing (*right photo, at right*).

Denver Section Hears Talk by Authority on Time Standards

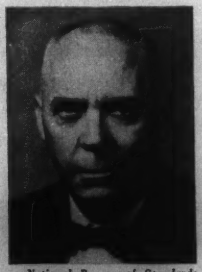
A. H. Morgan, chief, Radio Broadcast Service Section, Boulder, Colo., Laboratories of the National Bureau of Standards, spoke before the Denver Section, AIEE, at its November meeting. His subject was "Time and Frequency Standards and their Wide Distribution."

"The requirements for more accurate standards of frequency and time and their wide distribution without loss in accuracy have rapidly increased with advancements in the various fields of science, such as in missiles and satellite work," stated Mr. Morgan.

At high frequency, the vagaries of the propagation medium severely limit the accuracy of the received frequency and the time signals, he explained. Therefore, it was necessary to find another part of the radio spectrum that would provide much more stable signals over large areas of the world. At low frequency and very low frequency it has been shown that the signals do propagate with very high phase stability.

Now, techniques are at hand for exactly clocking the travel time of a single long wave, Mr. Morgan said. Such methods make it possible to use long waves with greater accuracy than formerly was possible with short waves.

Mr. Morgan is a member of the Research Society of America, the French-International Scientific Radio Union, and the (IRE) Institute of Radio Engineers' professional groups on instrumentation and electronic devices.



National Bureau of Standards

A. H. Morgan

During the meeting, L. M. Robertson, manager of engineering for the Public Service Company of Colorado in Denver, Colo., received the Certificate of Recognition for a retiring national director of AIEE "in recognition and appreciation of his valued services and contributions." W. L. Smith, president of the Denver Section, made the presentation. Active in numerous engineering organizations, Mr. Robertson is a graduate of the University of Colorado and is nationally recognized in the electric utility engineering field. He became a director of AIEE in 1956.

This meeting was held jointly with IRE and was also student branch night for the University of Colorado. Attendance at the meeting totaled 150.

ECPD's Annual Report States Accomplishments and Aims

The 28th annual report of the Engineers' Council for Professional Development (ECPD), reviews the Council's activities and accomplishments for the year 1959-60, and its aims.

W. L. Everitt, president of ECPD, described the Council as essentially a unity organization in his report, entitled "In Order To Form a More Perfect Union." He mentioned three major issues before ECPD which must be dealt with realistically in order to achieve better unity. These are the proposed amalgamation with EJC (Engineers Joint Council), the admission of new members to ECPD, and the activation of the EJC-ECPD Survey of the Profession.

The Guidance Committee reported on its national program, local activities, and future programs. The Education and Accreditation Committee listed a summary of accredited engineering curricula, including options, as of October 4, 1960. The desirability of instituting some ritual signalizing the change of status of a young man from a student of engineering to a full-fledged engineering graduate was projected as a major issue of the Student Development Committee for the forthcoming year.

The Committee on Development of Young Engineers summarized the distribution of literature. The Recognition Committee reviewed its projects of the last year, which included the definition of engineering, the professional title for engineer, the use of academic titles by authors, and membership grades. During the year 1960-61, the committee plans to continue these studies, and in addition, to consider the extent of engineers' unions and the effect of such unions on the professional status and the recognition of the engineer.

The Ethics Committee reviewed the plans and methods formulated this year that will enable the committee more fully to represent ECPD in the field of engineering ethics. The basis by which the membership of ECPD will be expanded was reported by the Planning Committee.

Reports of representatives of constituent organizations, which includes AIEE, also appeared in the ECPD's annual report.

Average Total Income of Engineering Teachers Rises

The average total professional income of engineering teachers has increased by 14.7% in the last 2 years, according to a report by the Engineering Manpower Commission of Engineers Joint Council. The survey, made possible through a grant from the National Science Foundation, covers more than 5,000 engineering teachers or more than half the total number.

Seventy-seven and one-half per cent of the average total income of engineering teachers is basic teaching salary and the remainder is derived from outside professional work such as consulting and research. Since the survey was first made in 1956, average basic teaching salaries have risen 31.1% and income from "outside sources" 11.3%.

Today's average basic teaching salary for engineering teachers in American colleges is $8,534. It is supplemented by an average of $2,479 from outside professional income.

In public institutions, the rise of 15.6% in total income was greater than that of 12.5% in private institutions due more to higher outside earnings than to a difference in the rise of basic teaching salaries. Such outside earnings for engineering teachers in public institutions increased 24.8% during the last 2 years as opposed to only 11.3% in private institutions. The basic teaching salary increase was 13.4% in public institutions compared with 13.0% in private institutions.

Other statistics of the report show that salaries increase with age, academic rank, and type of degree, and that the median teaching salary for instructors is $5,380, for full professors, $10,500.

"Salaries and Income of Engineering Teachers—1960" is the title of the report.

Public Service Company of Colorado

THE Certificate of Recognition for a retiring national director of AIEE was presented to L. M. Robertson (*right*), manager of engineering for the Public Service Company of Colorado, by W. L. Smith (*left*), president of the Denver Section, at the November Section meeting.

The survey was conducted in co-operation with the American Society for Engineering Education and prepared for the Manpower Commission by Prof. M. A. Horowitz of the Bureau of Business and Economic Research, Northeastern University, Boston, Mass. It is available at the Engineering Manpower Commission, 29 W. 39th St., New York 18, N. Y., at a cost of 25¢ for postage and handling.

The report is an adjunct to a more comprehensive survey of professional income of all engineers, scheduled for publication by the Commission later this year.

Growing Demand Revealed for Young Engineers' Literature

A large and growing demand for printed materials published for the benefit of young engineers was revealed in a report by John Gammell, chairman of the Committee on Development of Young Engineers of the Engineers' Council for Professional Development (ECPD), who reviewed the committee's annual report during ECPD's annual meeting on October 3 in Montreal, Que., Canada.

These publications, available to individuals, universities, technical societies, and industry, now include professional guides for young engineers, suggested readings lists, bibliographies, and a personal appraisal form.

A new publication, "Citizenship and Participation in Public Affairs," was presented for review by the committee. This booklet contains 24 pages and costs 25¢. A 25% discount will be allowed on 100 or more, and a 40% discount for more than 1,000 copies.

Another popular publication is ECPD's "First Five Years Kit," which costs $2. This comprises a complete set of professional development literature for young engineers in an attractive folder and envelope kit. A 40% discount will be allowed on 50 copies.

Both publications may be obtained from the Engineers' Council for Professional Development, 29 W. 39th St., New York 18, N. Y. Prepayment in cash, check, or stamps is requested with each order.

Glendale Power Dispatchers Are Hosts to National Association

The City of Glendale (Calif.) Public Service Department Power Dispatchers were hosts October 28-29 for the American Power Dispatchers Association's National Fall Meeting. Charles Merrell, City of Glendale Chief Dispatcher, was in charge of arrangements.

Les Norde, chief engineer for Motorola Corporation, addressed the group on Friday, October 28. He showed slides of Motorola's new Multi-Aperture Ferrite Logic. Application of ferro ceramics are just now being put to use in telemetry in industry.

Southern California Edison Company and Atomics International Division of North American Aviation Corporation sponsored a guided tour of Atomics International Division's SRE (Sodium Reactor Experiment) in the Santa Susana mountains October 29. The SRE had started operating again on September 5, and before very long will be providing enough heat to operate Southern California Edison's 7,500-kw steam electric generator adjacent to the reactor plant. More than 15 million-kwhr was generated at the Edison plant before the SRE was shut down in July 1959.

Lauren Grayson, general manager and chief engineer for the City of Glendale Public Service Department, addressed the group at a final dinner meeting Saturday night at the California Hotel in Glendale. "Water Utilities in the United States" was his topic, and a movie on the proposed Feather River Water Project was shown.

Prof. H. H. Goode Dies; Was Active in Computer Field

H. H. Goode, professor of electrical engineering at the University of Michigan and a prominent leader in the activities of the National Joint Computer Committee (NJCC) and several societies active in the computer field, died October 30.

Born in New York City on July 1, 1909, he received the bachelor of chemical engineering degree in 1904 from Cooper Union and the M.A. degree in mathematics from Columbia University in 1945.

University of Michigan
H. H. Goode

During the war years, he was research associate at Tufts College, worked on applications to war problems and also on the acoustic torpedo problem. Subsequently, he became head of the Special Projects Branch of the Office of Naval Research and later chief project engineer and director of the Willow Run Research Center. He also served as consultant to many firms and government agencies.

He was a member of Sigma Xi, Eta Kappa Nu, the Association for Computing Machinery, and the Institute of Mathematical Statistics. He was a Fellow of the American Association for the Advancement of Science, and a senior member of the Institute of Radio Engineers.

Prof. Goode was chairman of the NJCC of which the AIEE is a sponsor. He served on the AIEE Feedback Control Systems Committee (1958-61).

AIEE PERSONALITIES

F. A. Allehoff (M '58) has been named sales engineer by S&C Electric Company for the western half of the State of Washington. Mr. Allehoff also will continue to cover Oregon, northern Idaho, western Montana, and eastern Washington.

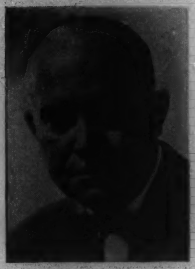
W. E. Barbour, Jr. (M '48) is president of the newly formed corporation, Magnion, Inc., of Cambridge, Mass. Magnion was formed to work in the area of research and development of magnetic systems and products. Mr. Barbour has served on the AIEE Nucleonics Committee (1948-61, chairman 1954-56) and Nuclear Congress and Nucleonics Committee (1958-61).

Appointed to the newly established Advisory Committee on Calibration and Measurement Services of the National Bureau of Standards are: **H. C. Biggs** (AM '41, M '51), manager physical and electrical standards department, Sandia Corporation, Albuquerque, N. Mex.; **W. G. Amey** (AM '47, M '54), manager, Research Division, Leeds & Northrup Company, North Wales, Pa.; **I. G. Easton** (AM '41 M '49), vice-president for engineering, General Radio Company, West Concord, Mass. **J. W. McNair** (AM '25), technical director, American Standards Association, New York, N. Y., has been appointed to the National Bureau of Standards' newly formed Advisory Committee on Engineering and Related Standards. Dr. Amey has served on the AIEE Research Committee (1957-60) and Fundamental Electrical Standards (1960-61). Dr. Easton is a member of the AIEE Electronic and High Frequency Instruments Committee (1956-61) and Fundamental Electrical Standards Committee (1960-61).

J. R. Bradburn (M '50), vice-president of manufacturing and engineering for Burroughs Corporation, Detroit, Mich., has been elected to the corporation's Board of Directors.

R. D. Bradley (M '59) has been assigned as manager of the new technical services department of the Research and Development Division of Day-Brite Lighting, Inc.

J. B. Castle (AM '50), formerly manager of the East Central Sales Division of the S&C Electric Company, Chicago, Ill., has been named to head the new national Sales Services Division of the company. **P. J. McLaughlin** (AM '55) has been promoted from assistant manager to manager of the East Central Sales Division, which includes Illinois, Wisconsin, Michigan, Ohio, Indiana, Kentucky, Florida, Georgia, Tennessee, Alabama, North and South Dakota, and Minnesota.



M. G. Crosby

M. G. Crosby (M '41, F '51), president of Crosby-Teletronics Corporation, has been appointed to the government's Patent Advisory Committee by Secretary of Commerce F. H. Mueller. Mr. Crosby holds more than 180 patents in the field of communications, and his system for transmitting stereophonic broadcasts by FM stations is presently under consideration by the Federal Communications Commission for permanent broadcast licensing.

R. E. Deal (AM '49) has been appointed general sales manager of the James R. Kearney Corporation, St. Louis, Mo. Mr. Deal was formerly manager of marketing with the 3E Company which was recently acquired by Kearney.

E. B. Delany (AM '52) has been appointed product line manager of process control for the Instrument Division of the Perkin-Elmer Corporation, Norwalk, Conn. Prior to this position, Mr. Delany was group leader in process control for Perkin-Elmer's Instrument Division.

R. J. Dineen (AM '57) has been manager of the centrifugal pump department of the Allis-Chalmers Manufacturing Company's Norwood, Ohio, Works. Mr. Dineen was previously manager, product sales, electrical department, Norwood Works.

Peter Elias (M '60) has been appointed full professor and head of the department of electrical engineering at the Massachusetts Institute of Technology (MIT). Dr. Elias became an assistant professor at MIT in 1953 in the electrical engineering department and Research Laboratory of Electronics. In 1956, he was advanced to associate professor, and in 1960, to professor and head of the department of electrical engineering. He has been working on two-dimensional random processes and pictures as information sources, efficient coding of redundant sources, and noisy channel coding problems.

Herbert Freeman (AM '49, M '56) has been appointed associate professor in the department of electrical engineering at New York University, Bronx, N. Y. Dr. Freeman was formerly head of the military data processing department of the Sperry Gyroscope Company, Great Neck, N. Y. He is a member of the AIEE Education Committee (1960-61).

R. F. Gilkeson (AM '40, M '47) has been appointed manager of the newly created engineering and research department, Philadelphia Electric Company, Philadelphia, Pa. He had been serving as superintendent of the utility's newest electric generating station at Eddystone, Pa. Other appointments in the engineering and research department include: **A. H. Kidder** (AM '29, F '50), who was named assistant to the vice-president; **C. W. Bary** (AM '25, F '56), named director of economic and rate analysis, and **J. A. Thielman** (AM '26, M '43), assistant director, economic and rate analysis. At the same time, **T. S. Fetter Jr.** (M '54), formerly executive engineer, was named assistant to the president of the utility. Mr. Kidder has served on the following AIEE Committees: Code of Principles of Professional Conduct (1952-60, secretary 1959-60), Research (1958-61), and Board of Examiners (1959-60). Mr. Bary is a member of the AIEE Domestic and Commercial Applications Committee (1952-60).

Raymond Guy (M '57, F '59) has retired from the National Broadcasting Company–Radio Corporation of America after 42 years with the company. He has entered the field of engineering consultation and representation in AM, FM, TV, and international broadcasting, with headquarters in Haworth, N. J. Recently, he was named senior staff engineer of the company after many years as director of radio and allocations engineering, with responsibility for planning and building all the company's transmitting facilities. Mr. Guy has served on the AIEE Broadcasting Committee (1956-61).

Percy Halpert, formerly chief of Sperry Gyroscope Company's aeronautical equipment engineering operations at Great Neck, N. Y., has been appointed to the position of division manager of Sperry Rand and will be resident in Phoenix, Ariz. Sperry's radio and radar engineering facilities at Sunnyvale, Calif., will be managed under Mr. Halpert's cognizance, as well as all Sperry Phoenix Company programs.

H. G. Hammond (AM '46, M '55), assistant general superintendent of the meter department at Detroit Edison Company, Detroit, Mich., retired November 1 after 47 years of service with the company. Mr. Hammond joined Detroit Edison as a meter tester's helper in 1913. Later, he was assigned to the standards laboratory of the meter department where, as supervising engineer, he contributed greatly to the development of improved meter testing equipment and methods. He served the department as assistant general superintendent since 1956. Mr. Hammond has served on the AIEE Indicating and Integrating Instruments Committee (1956-61).

C. W. Higbee (AM '37), who retired recently as assistant general manager, Electrical Conductor Division, Kaiser Aluminum and Chemical Sales, Inc., has been retained as a consultant by the National Electrical Manufacturers Association to study import problems affecting the insulated wire and cable industry.

P. W. Jackson (AM '50), previously executive assistant to International Business Machines Corporation's vice-president and group executive at corporate headquarters in New York City, has been promoted to manager of East Coast laboratories in the corporation's Advanced Systems Development Division. In his new position, Mr. Jackson is manager of engineering and scientific development work at the division's East Coast locations, including Yorktown, Peekskill, and Ossining.

N. C. Joehlin (AM '47) has been appointed head of the Digital Systems Group at Vitro Laboratories, West Orange, N. J. Mr. Joehlin was formerly senior engineer of Magnavox Company in Urbana, Ill., and Fort Wayne, Ind.

Paul Lebenbaum, Jr. (AM '37, M '47) has been appointed manager of the Palo Alto, Calif., plant of International Telephone and Telegraph Corporation's Components Division. He has been placed in charge of the engineering, manufacture, and marketing of tantalum capacitors and hermetic seals. Mr. Lebenbaum formerly was senior systems designer and consultant on automation in the Industrial Electronics Division of General Electric Company, Schenectady, N. Y.

R. B. Le Vino (AM '39, M '49) has been elected vice-president of research and engineering of Smith-Corona Marchant Inc. His responsibilities include research, product planning, patent administration, and industrial design. In addition, he has staff responsibility for engineering for all of the corporation's manufacturing divisions. Mr. Le Vino has been associated with Smith-Corona Marchant since 1957 when he joined the corporation as director of product planning. He has served on the AIEE Telegraph Systems Committee (1955-61).

Benjamin Levinson (AM '45) has been appointed chief engineer of Chester Cable Corporation, Chester, N. Y., a subsidiary of Tennessee Corporation. Mr. Levinson was formerly associated with the Okonite Company for 19 years.

J. F. Lincoln (AM '08, F '39, Member for Life), chairman of the Board of the Lincoln Electric Company, Cleveland, Ohio, was presented with the James H. McGraw Award Manufacturers Medal at the 34th annual meeting of the National Electrical Manufacturers Association held in November. Mr. Lincoln was cited for his "outstanding leadership and inspiration in the creation and development of the electric arc welding process and industry." The award consists of a medal and purse given in recognition of the recipient's outstanding personal contributions to progress in the industry. The présentation to Mr. Lincoln was made by A. F. Metz, executive consultant to the Okonite Company, who told of Mr. Lincoln's vision in changing the arc welding process from "an emergency tool" into an industry. Mr. Lincoln's inspiration, said Mr. Metz, has "guided the direction and progress of arc welding until today it is universally accepted and used as a production and construction process as well as a maintenance tool wherever metals are used." The Cleveland manufacturer

also was cited for his "dynamic leadership" in organizing welding schools and engineering seminars as well as in establishing the James F. Lincoln Arc Welding Foundation for the promotion of arc welding "through scientific and engineering education."

H. T. Lowell, Jr. (AM '56), formerly sales manager of Sperry Products Company, Division of Howe Sound Company, has been appointed director of sales for its Robinson Vibrashock Division.

W. G. Matheson (AM '53), manager of incandescent lamp research for Sylvania Lighting Products, a division of Sylvania Electric Products Inc., Salem, Mass., has been elected to the Committee of Honor for the 1961 meeting of the French Vacuum Society in Paris, France. Sylvania is a subsidiary of the General Telephone & Electronics Corporation. Mr. Matheson served during the last year as president of the American Vacuum Society.

C. W. Miller (AM '47), formerly assistant to the executive vice-president of Perkin-Elmer Corporation, Norwalk, Conn., has been appointed to the newly created position of technical manager.

Eugene Mogul (AM '47) has been appointed manager, systems planning, Loral Electronics Corporation, New York, N. Y. Mr. Mogul's responsibility encompasses market planning and co-ordination for the company's advanced military electronic systems. He was previously marketing and sales manager, Inertial Switch, Inc.

Clark Nichols (AM '36, M '58) has been made manager of the Systems Engineering Division of Leeds & Northrup Company, Philadelphia, Pa. He was formerly head of the company's Application Engineering Utilities Section. Mr. Nichols has served on the AIEE System Engineering Committee (1952-60).

P. F. O'Neill (AM '41) has been appointed manager of electrical systems engineering and design of General Elecrtic's Residential Market Development Operation. He is responsible for the application of the company's products on a project basis for large Medallion Home subdivisions and apartment buildings and is located at Appliance Park headquarters. He was formerly specialist—utility relations in behalf of the five product departments in the company's Major Appliance Division.

H. S. Osborne (AM '10, F '21, Member for Life), consulting engineer of Upper Montclair, N. J., presented an address, entitled "Telecommunication and International Standardization," at a recent meeting sponsored jointly by the Japan Institute of Electrical Engineers, the Japan Institute of Communication Engineers, and the Tokyo Section of the Institute of Radio Engineers. A dinner was given for Dr. Osborne by the Japanese National Committee of the International Electrotechnical Commission, at which representatives of the Japanese Standards Association and the Japanese Industrial Standards Committee were present. Dr. and Mrs. Osborne spent a month in Japan enroute to meetings of the International Electrotechnical Commission in New Delhi. Dr. Osborne has served as AIEE president (1942-43), director (1938-42), and as a member of the following AIEE Committees: Standards (1917-28, chairman 1923-26, ex officio 1949-50), Technical Program (1924-25, 1927-29, 1931-34, 1936-41, chairman 1936-39), Communication (1929-37, chairman 1931-34), Award of Institute Prizes (1936-40, chairman 1936-39), Professional Development and Recognition Department (1958-60), Finance (chairman 1939-42), Executive (1939-45, chairman 1942-43), and Volta Scholarship Trustee (1949-60, chairman 1949-60).

J. G. Reifsnyder (AM '44) of the electrical engineering department, Lafayette College, Easton, Pa., was a recipient of the Jones Fund superior teaching award during Lafayette College Founders' Day ceremonies on October 29. K. R. Bergethon, president of Lafayette College, made the faculty presentation at a Founders' Day convocation. The $500 award was made possible by the Thomas Roy and Lura Forrest Jones Fund for the Reward of Superior Teaching.

T. M. Robertson (AM '52, M '56) has been named to a new post, manager of anti-submarine warfare planning, at Vitro Laboratories' Silver Spring, Md., Laboratory. He was formerly head of the Laboratory's systems development department. **W. L. Freienmuth** (AM '48, M '56) was named acting head of the systems development department to replace Mr. Robertson. Mr. Freienmuth continues in a dual capacity as assistant manager of the Technical Operations Office.

L. A. Rosenthal (AM '44), Rutgers professor of electrical engineering, has received a patent on a continuous measuring apparatus and method he developed as a consultant to the Union Carbide Corporation of Bound Brook, N. J. His latest invention, the seventh for which he has been granted a patent, is an automation system for making routine measurements on chemical, plastic, or similar materials.

R. G. Slauer (AM '41, M '48), manager of engineering in the Fixture Division of Sylvania Electric Products Inc., Wheeling, W. Va., has been elected president of the Illuminating Engineering Society for 1960-61. Mr. Slauer is a graduate of the Stevens Institute of Technology from which he received the M. E. degree in 1926. He joined the General Electric Company, Harrison, N. J. and stayed with the company for a period of 4 years. Mr. Slauer was associated with Westinghouse Electric Corporation, Bloomfield, N. J., for 14 years. He has been employed by Sylvania since 1944.

W. M. Spain (AM '41, M '56), previously regional manager for the Federal Pacific Electric Company, Chicago, Ill., has been appointed executive vice-president of the W. T. Foley Electrical Supply Company, Inc., Kansas City, Kans.

H. M. Van Bemmelen (A M'51) of Woodland Hills, Calif., has been named district sales manager for the General Electric Company's semiconductor products department. He joined the department in 1959.

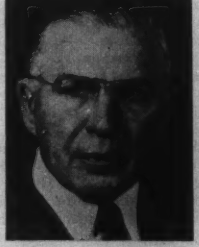
H. M. Wilkinson (AM '44, M '52) has been appointed manager of the Data Acquisition and Logging Section of Stromberg-Carlson's Electronics Division, Rochester, N. Y. Mr. Wilkinson is responsible for design and construction of data-acquisition systems in both military and commercial fields. Previously, he was in charge of Instrumentation Systems at Epsco, Inc., Cambridge, Mass.

H. S. Wilson (AM '57) has been named custom microwave project manager, Communications and Controls Division, Radio Corporation of America, New York, N. Y. Mr. Wilson currently is concerned with the construction of a coast-to-coast Western Union microwave system.

R. R. Wylie (M '46), previously marketing manager of Sangamo Electric Company, Springfield, Ill., has been appointed manager of electronic products sales. **Glenn DeKraker** (AM '52), former assistant marketing manager, has been made manager of marketing services. He will also assist Mr. Wylie as sales manager of electronic systems.

OBITUARIES

Ralph Douglas Booth (AM '24, M '42, F '53, Member for Life), president, Jackson & Moreland, Inc., Engineers, Boston, Mass., died November 21 at the age of 61. He was born February 4, 1899, in Methuen, Mass., and received the B.S. degree in electrical engineering from the Massachusetts Institute of Technology in 1920. Shortly after graduation, Mr. Booth joined Jackson & Moreland, then a partnership, as an assistant engineer. In 1927, he was made a partner, and thereafter was assigned to the design and construction for Cascade electrification of the Great Northern Railway. He was in charge of an analysis of relative merits of a-c and d-c distribution for the New York Edison Company and of an analysis for the Boston Edison Company of their purchase of 150,000 kw from the New England Power Association. Mr. Booth was assigned to the economic investigation, design, and supervision of construction for



R. D. Booth

the Hoboken suburban electrification of the Delaware, Lackawanna & Western Railroad. During World War I, he was appointed a member of the Office of Scientific Research and Development, for which he later was named a deputy chief. Mr. Booth was a licensed engineer in 17 states and Puerto Rico, and was a member of the American Petroleum Institute and the Conference Internationale des Grands Reseaux Electriques. He served on the AIEE Power Transmission and Distribution Committee (1926-27).

Clifford Cheethorn Carr (AM '30), assistant dean of the School of Engineering, Pratt Institute, Brooklyn, N. Y., died December 9. Born May 4, 1898, in Newburgh, N. Y., he graduated in 1918 from Rensselaer Polytechnic Institute where he studied electrical engineering. He served in the U. S. Naval Reserve Force during 1918-19 as an engineering ensign, and the following year was employed as an electrical engineer at the Newburgh Shipyards Inc., Newburgh, N. Y. In 1920, he joined the faculty of Pratt Institute as an instructor in electrical technology, and during 1938-58 he served as chairman of the Electrical Engineering Department. Dean Carr revised the "American Electrician's Handbook" five times in 1932-53. He was a past chairman of the Middle Atlantic Section of the American Society for Engineering Education.

Robert Henry Crone (M '36), engineering business development representative, Ebasco Services Inc., New York, N. Y., died December 21 at the age of 60. Mr. Crone was born July 12, 1900, in Wrightsville, Pa., and received the B. S. degree in electrical engineering in 1923 from Pennsylvania State College. Associated with Ebasco Services and its affiliates for almost 35 years, Mr. Crone supervised design and construction of many major hydroelectric and power facilities throughout the United States. He joined the company as a cadet engineer in 1923 after graduation from college. Mr. Crone recently completed a 15-month special assignment at Princeton University on Project Matterhorn, a thermonuclear fusion research and development facility, authorized and directed by the U. S. Atomic Energy Commission. In World War II, as a lieutenant commander in the U. S. Navy, he supervised the installation and maintenance of harbor entrance communications at Government locations on the West Coast and in the Panama Canal Zone. He was a member of the National Society of Professional Engineers, the New York State Society of Professional Engineers, and Eta Kappa Nu. He was a licensed engineer in the States of New York, New Jersey, Colorado, and North Carolina.

Marion Eppley (M '31, F '52), president of Eppley Laboratory, Inc., Newport, R. I., died November 22 at the age of 77. Born June 19, 1883, in West Orange, N.J., he was educated at Princeton University, from which he received the B.S. degree in 1906, the M.A. degree in 1912, and the Ph.D. degree in 1919. He was awarded the honorary D.Sc. degree from Rhode Island State College, now the University of Rhode Island, in 1941. A retired U. S. Naval Reserve captain, he served in the Navy in both World Wars and was a member of the Board of Visitors of the U. S. Naval Academy. Capt. Eppley was the founder of the Eppley Foundation for Research, Inc., and the Eppley Laboratory, Inc., both in Newport. He entered active naval service in 1917, and the following year was assigned as acting experiment officer in charge of torpedo experiments and depth-charge and similar operations. During this period, he established the Eppley Laboratory for the manufacture of standard cells. The company later expanded into the field of precision electrical measuring instruments. In 1926, he received the Howard N. Potts Gold Medal from the Franklin Institute of Philadelphia for his work on electrical standard cells. Captain Eppley returned to active naval duty in 1941 as operations and security officer of the Operating Base at Newport. A year later, he became chief of staff of the Narragansett Group Eastern Sea Frontier. Capt. Eppley was a Fellow of the American Institute of Chemists, the American Physical Society, the New York Academy for the Advancement of Sciences. He served on the AIEE Instruments and Measurements Committee (1930-37) and Research Committee (1938-40).

John W. Hancock (AM '10, Member for Life), retired manager, Roanoke-Lynchburg division, Appalachian Electric Power Company, Roanoke, Va., died November 12 at the age of 90. He was born at Hale's Ford, Franklin County, Va., on June 17, 1870. Mr. Hancock was appointed superintendent of the Roanoke Street Railway Company and the Roanoke Electric Light and Power Company in 1899, while these companies were being operated by a receiver. When the Roanoke Railway and Electric Company was formed, Mr. Hancock was elected secretary. He remained in that capacity until 1901, when he was appointed general manager. In 1913, he also became general manager of the Lynchburg Traction and Light Company, and continued as general manager of these companies until the formation in 1926 of the Appalachian Electric Power Company, when he was made division manager of the newly formed Roanoke-Lynchburg Division. He held that position until his retirement in 1944 after having given almost 50 years of continuous service to the utility industry. He also served as a director of the Appalachian Electric Power Company for several years. Mr. Hancock was instrumental in the formation in 1933 of the Southeastern Electric Exchange, Atlanta, Ga., and served as its first president. He assisted in the formation of the Virginia Utilities Association in 1906 and served as its president and director. He was a former president of the Southwestern Division of the National Electric Light Association.

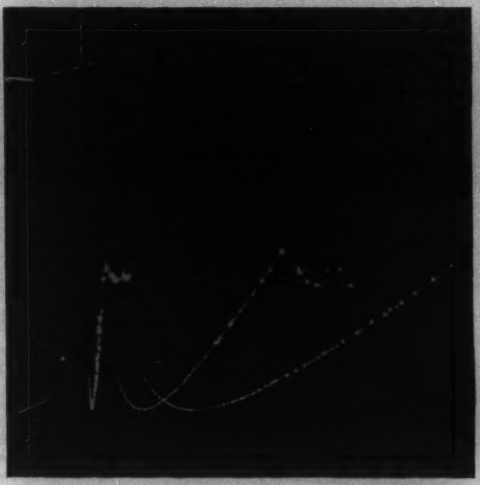
Oliver Mageehon (AM '46, M '51), manager, electrical system planning, General Electric Company, Richland, Wash., died November 22, 1960. He was born July 17, 1909, in Galt, Mo., and received his B. S. degree in electrical engineering from Finlay Engineering College, Kansas City, Mo., in 1931. Prior to Mr. Mageehon's joining General Electric in Richland in 1947, he was employed by Willamette Iron & Steel Corporation and Bethlehem Shipbuilding Corporation in various engineering positions. Nine of his 13 years with General Electric were spent in supervisory positions in both electrical and telephone facilities.

Albert A. Maxwell (AM '47, M '58), manager, Electric Utility Operation, General Electric Company, Richland, Wash., died November 18. Mr. Maxwell was born April 18, 1919, in Rapid City, S. Dak., and graduated from the South Dakota School of Mines in 1942 from which he received a B. S. degree in electrical engineering. After graduation, he joined E. I. duPont as an engineer and worked in that capacity until 1946 at their installations in Joliet, Ill.; Kings Mills, Ohio, and Richland, Wash. When General Electric assumed operation of the Richland installation in 1946, Mr. Maxwell accepted a position as area engineer. He was named supervisor of Line Maintenance in 1952, supervisor of Substation Maintenance and Operation in 1953, and manager of Electrical Utility Operation in 1957. Mr. Maxwell was chairman of the Richland Section during 1959-60.

Hans Joachim Rister (AM '59), an engineer in the Propulsion Wind Tunnel Facility of ARO, Inc., Tullahoma, Tenn., died recently at the age of 60. He was born November 25, 1900, in Zarrentin, Mecklenburg, Germany. During 1926-41, Mr. Rister was a master electrician and supervisor at a municipal power plant at Husum, Germany. The war years came, and Mr. Rister received an appointment as an electrical engineer at the Herman Goering Aeronautical Research Institute in Brunswick, Germany, where he was in charge of the power plant, drive system, and test section for the Institute's 10- by 10-foot high speed wind tunnel. Mr. Rister did extensive work with optical systems used in wind tunnel systems and was closely associated with Dr. T. W. Zobel in the development of interferometer and schlieren devices. After World War II, Mr. Rister and other German scientists were brought to this country and were stationed at Wright Field, Dayton, Ohio, where they continued their work in aeronautical research. In 1953, Mr. Rister was employed by ARO, Inc., in Tullahoma, Tenn., as an electrical engineer in charge of the 216,000-hp main drive system for the Arnold Engineering Development Center's Propulsion Wind Tunnel. In this capacity, Mr. Rister was largely responsible for placing this system in service and was instrumental in training operators for the system.

Anton William Schmitz (M '50), manager of engineering operations, General Electric Company, Salem, Va., died recently. He was born February 26, 1905, in M. Gladbach, Germany. Mr. Schmitz was a General Electric employee for 37 years. In 1951, he received General Electric's Coffin award, the company's highest award for outstanding achievement. At the time of his death, he was manager of engineering operations dealing with control systems for industrial processes and machinery at Salem's General Electric plant.

OF CURRENT INTEREST

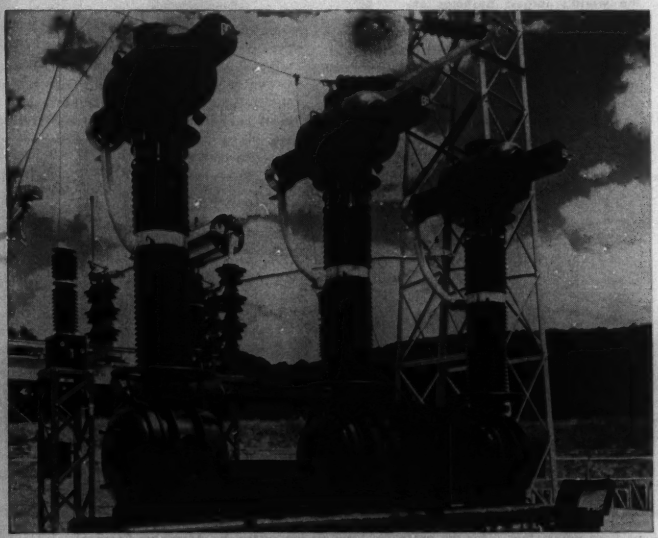


CONDUCTORS, energized at the world's highest voltage, are aglow with corona at General Electric's Project EHV. Corona, a discharge of electricity, is emitted because the three single conductors are arranged for a transmission of 460,000 volts, but are being energized at the new world high of approximately three-quarters of a million volts. Conductors coming into the transmission tower from upper right are without corona because they are bundled in groups of four—the proper arrangement for transmissions up to 750,000 volts. Later, all conductors will be arranged in this manner.

Project EHV Energized at 460–750 Kv

PROJECT EHV (Extra-High-Voltage) was energized by General Electric with a new world mark of approximately three-quarters of a million volts. The outdoor laboratory, located near Pittsfield, Mass., will operate for the next few years at a range of 460 to 750 kv.

The north section of the 2-section 4.3-mile prototype system received the record voltage that puts the United States ahead of the USSR and other foreign countries as the world leader in ehv transmission. The highest operating transmission voltage in Russia is 500,000 volts. A 0.6-mile experimental line near Leningrad is reportedly testing at 600,000 volts.



DESIGNED AND BUILT by GE's high-voltage switchgear department, this 115-kv air-blast power circuit breaker, representing the most modern design available, protects Project EHV equipment. Shown undergoing insulation tests during installation, the air breaker is less than half as heavy as a conventional oil breaker of similar rating. Using compressed air to snuff out power arcs during short-circuit interruption, the design is available in ratings to 460 kv and higher.

Project EHV will help solve the numerous problems encountered by electric utilities who plan ehv lines to answer America's demands for increased power at continued economical rates.

According to Dr. P. A. Abetti, project manager, "extra-high voltage is a sensible, economical way to help supply America's need for twice as much power within the next 10 years." He explains that one 750,000-volt line will transmit over 36 times as much power as one 115,000-volt line. Savings in construction costs, buying expensive rights-of-way, towers, conductors, and apparatus result. This will help utilities offer continued economical rates in the face of rising costs.

The new techniques used at Project EHV were predetermined by extensive analytical studies, computer and model investigations, and laboratory work. They will be verified under actual field operations. If the technology needs correction or refinement, it will be more economical to find out on an experimental line, such as Project EHV, than on a utility's fully constructed, operational system.

Six companies and 15 General Electric product departments have contributed to the newly completed northern section of the $7.5 million project, co-ordinated by the company's power transformer department, Pittsfield. Six other companies are supplying material for the southern section, due to be completed in mid-1961.

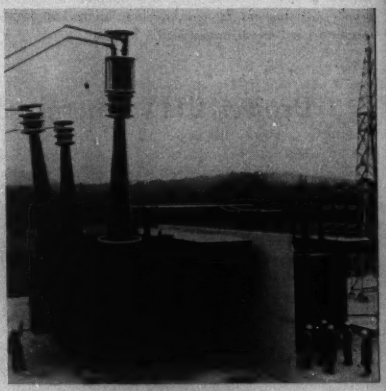
Assistance is being rendered by an Advisory Council, composed of executives and engineers from 15 United States and Canadian utilities, and a Consulting Engineers Committee, numbering engineers from 14 consulting engineering firms.

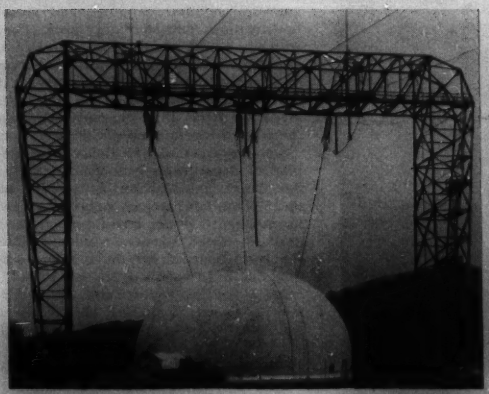
A total of 267 measurements of 47 types are being performed: 133 electrical of 13 types; 71 mechanical of 11 types; and 63 meteorological of 23 types. Being measured are radio and television influence, voltage surges and current, axial tension, maximum angle of swing, amplitude and

AERIAL VIEW of north section of General Electric's Project EHV located in the Berkshires near Pittsfield, Mass.

◄ 106-foot Alcan Guyed Tower, the world's largest, is located at Project EHV. It was designed by Aluminium Limited and manufactured by the Michael Flynn Manufacturing Company.

► Power transformer, left of concrete wall, steps up incoming voltage to a range of 460,000 to new world high of 750,000 volts at Project EHV. Regulating transformer, at right, regulates the 115,000-volt incoming supply by ±30% to allow different voltages to be tested on the line. Probably the world's largest bushings extend 18 feet above and 10 feet into the power transformer.





MAN-MADE LIGHTNING of 3 million volts will shoot from within this bubble *(above, left)* and bombard conductors at Project EHV. An impulse generator will produce the artificial lightning which will test the experimental system's lightning resistance—without having to wait for an electrical storm to pass over. *Above, right:* Huge 2.32-inch diameter conductor comes off reel at Project EHV. The conductors, especially made for the prototype transmission system by Aluminum Company of America, went through the tensioning machine, up to 30-inch sheaves on tower no. 1, on to tower no. 2 *(rear)*, and then to tower no. 3 *(not visible)*. Conductor was pulled through from tower no. 3. A drag was used to keep the conductors from hitting the ground. The tensioning apparatus was supplied by Peterson Engineering Company.

frequency of aeolian vibrations, temperature, wind velocity and direction, lightning, and corona loss.

Mounted atop the transmission towers, 40-foot lightning rods will attract nearby lightning strokes that would otherwise narrowly miss the line. Later, an impulse generator will send man-made 3,000,000-volt lightning bolts to the line.

Instruments will feed information to a General Electric type *310* data acquisition computer. It will gather and record measurements at 20-minute intervals in fair weather and 2-minute steps in foul weather. This averages out to 10 readings per hour, 24 hours a day, 7 days per week for a total of more than 10 million annual readings. At Project EHV's terminal building, the data is recorded on paper tape, converted to magnetic tape and processed in a *705* computer to provide technical information in the form required for analysis.

The project draws power from a nearby Western Massachusetts Electric Company 115,000-volt line. Disconnect switches completely isolate the station when necessary, while coupling capacitors provide potential for relaying and metering the voltage to a 40,000-kva regulating transformer that covers in 72 steps the entire voltage range under study.

Connection is then made to the world's highest-voltage power transformer, built by General Electric and rated 650 kv, 1,925 BIL. The voltage is brought out through the top of what are believed to be the world's largest high-voltage bushings, rated 2,050 BIL.

The conductors, supplied by Aluminum Company of America, will be tested at 460 kv with spacings of 20, 30, and 38 feet and at 750 kv with spacings of 45 and 50 feet. Single 2.32-inch 2,995-MCM conductors, as well as bundles of two "plovers" (1.465 inches, 1,431 MCM) and three "cardinals" (1.196 inches, 954 MCM) will be tested at 460 kv. Three plovers and four cardinals will be used at 750 kv.

Each conductor phase is held below the transmission towers by two strings of from 26 to 40 insulators, ranging 20 to 30 feet in length. The insulators can withstand a strain up to 36,000 pounds.

Corona shields and various pieces of line hardware are supplied by Brewer Titchener Corporation.

The three portal transmission towers, designed by American Bridge Division of United States Steel, are the largest of their type. Tower no. 2 weighs 134 tons, is 128 feet high, and 182 feet wide. Towers 1 and 3 are somewhat smaller. All three rest on sand that has been firmed by explosives.

Stringing the conductors the 1,469 feet from tower 1 to tower 2 and 1,531 feet from tower 2 to 3 consumed 77 hours, many times that required for normal tension stringing. However, special care was necessary to maintain proper wire sag, hold wire tension nearly constant, and insure that the conductors would not hit the ground and thus bring corona losses due to frayed edges. The work of erecting the conductors, as well as designing and constructing the entire line was supervised by Stone & Webster Engineering Corporation. Peterson Engineering Company supplied the tension-stringing equipment.

The south section of Project EHV, stretching 3.9 miles, will be connected to the present section and also to the Western Massachusetts Electric Company line when it is completed in mid-1961. Beginning in late 1963 the Project EHV link will be operated by Western Massachusetts as an integral part of their system to supply power for Pittsfield. **EE**

USIA Magazine Offers Engineering Article

People in Poland who are interested in engineering currently have an opportunity to read about Harvey Slocum who is building India's Bhakra Dam in the Himalayan foothills. The project will generate 900,000 kw of electricity and irrigate millions of acres.

The article "Harvey Slocum: Dynamic Dam Builder" appears in *America Illustrated* (No. 21), a Polish-language magazine about America, distributed in Poland by the United States Information Agency.

Following is an excerpt from an English translation of the article.

Harvey Slocum: Dynamic Dam Builder
By Booton Herndon

One of the biggest construction jobs of the century, the Bhakra Dam, is going on in a deep gorge in the foothills of the Himalayas in India. Just looking at it is a moving experience, and Prime Minister Nehru described it as "something tremendous, something stupendous and something which shakes you up when you see it."

The boss of this huge undertaking is a stocky, erect little American named Harvey Slocum. He is the best dam man in the world and he knows it. You might mistakenly size him up, at first, as an irascible blowhard with a colossal conceit. But if you observe him and his works for years, as I have, you would come to the conclusion that Slocum is just as good as he says he is.

Bhakra is Slocum's biggest job. In fact, he calls it "the toughest job of all time." When completed, it will be about 230 meters (755 feet) high, 520 meters (1,705 feet) long at the crest, 190 meters (624 feet) wide at the base. Slocum has been pouring 400 tons of concrete an hour, 24 hours a day into Bhakra since November 1955, and the dam won't be finished until the end of 1961. It will back up a reservoir 90 kilometers (56 miles) long; 366 villages will be flooded out. Its water will irrigate a desert area of about 26,000 square kilometers (7,800 square miles).

Until Bhakra is finished, Grand Coulee, across the Columbia River in Washington, remains the biggest dam Slocum has built. He has also had his finger in Hoover (formerly Boulder) Dam, America's highest, and Shasta, second highest. (Bhakra will be higher than both.) He built Bull Shoals Dam in Arkansas, Friant in California, Madden in the Panama Canal Zone, and a half dozen others. During his turbulent career, he has built more dams than any other single man in history.

Future Meetings of Other Societies

Pennsylvania Electric Association
Systems Operation Committee Winter Meeting, Feb. 9-10, Harrisburger Hotel, Harrisburg, Pa. C. S. James, South Penn Power Co., 55 E. Washington St., Hagerstown, Md.

Electrical Equipment Committee Winter Meeting, Feb. 16-17, Pick-Roosevelt Hotel, Pittsburgh, Pa., PEA, Engineering Section, Electrical Equipment Committee

National Rural Electric Cooperative Association, Annual Meeting, Feb. 12-16, Dallas, Texas. National Electrical Manufacturers Association, 155 E. 44th St., New York 17, N.Y.

ASHRAE, 15th International Heating & Air-Conditioning Exposition, Feb. 13-16, International Amphitheatre, Chicago, Ill. International Exposition Co., 480 Lexington Ave., New York 17, N.Y.

2nd Annual Symposium on Nondestructive Testing of Aircraft and Missile Components, Feb. 14-16, Gunter Hotel, San Antonio, Texas. R. B. Wangler, Southwest Research Institute, Box 2296, San Antonio.

Denver Electrical and Electronics Exhibit, Feb. 21-22, Denver Hilton Hotel, Denver, Colo. Same, 1441 Welton St., #326, Denver 2.

Pacific Electronic Trade Show, Feb. 26-Mar. 1, Great Western Exhibit Center, Los Angeles, Calif. Same, 2216 South Hill St., Los Angeles 7.

AIME, Annual Meeting, Feb. 26-Mar. 2, Chase & Park Plaza Hotels, St. Louis, Mo. Same, 29 W. 39th St., New York 18, N.Y.

3rd National Lighting Exposition, Mar. 5-8, Coliseum, New York, N.Y. National Lighting Expositions, 550 5th Ave., New York 36.

6th Annual Gas Turbine Conference & Exhibit, Mar. 5-9, Shoreham Hotel & Pentagon, Washington, D. C. The American Society of Mechanical Engineers, 29 W. 39th St., New York 18, N.Y.

ISA, 11th Annual Conference on Instrumentation for the Iron & Steel Industry, Mar. 8-10, Roosevelt Hotel, Pittsburgh, Pa. R. R. Webster, Jones & Laughlin Steel Corp., Research Laboratory, 900 Agnew Ave., Pittsburgh 30, Pa.

2nd Symposium on Engineering Aspects of Magnetohydrodynamics, Mar. 9-10, University of Pennsylvania, Philadelphia, Pa. Institute of Radio Engineers, 1 E. 79th St., New York 21, N.Y.

3rd Annual Industry Missile and Space Conference, Mar. 10-12, Cobo Hall, Detroit, Mich. Michigan Aeronautics and Space Association, 901 Book Bldg., Detroit 26.

ASME Aviation Conference, Mar. 12-16, Statler Hilton Hotel, Los Angeles, Calif. The American Society of Mechanical Engineers, 29 W. 39th St., New York 18, N.Y.

National Association of Corrosion Engineers, Annual Conference & Corrosion Show, Mar. 13-17, Statler Hotel, Buffalo, N.Y. Air-Conditioning & Refrigeration Institute, 1346 Connecticut Ave., N. W., Washington 6, D. C.

Overseas

10th Electrical Engineers Exhibition, Mar. 21-25, Earls Court, London. Electrical Engineers (ASEE) Exhibition Ltd., 6 Museum House, 25 Museum St., London, W. C. 1, England.

The Engineering, Marine, Welding & Nuclear Energy Exhibition, Apr. 20-May 4, London. A. Seligman, 9 Malcolm Rd., London, S.W. 19, England.

Optical Maser Advance Promises New Use of Light Waves

A SIGNIFICANT scientific advance which, for the first time, will permit continuous generation of coherent light waves for possible space communications and scientific and industrial uses was announced recently by International Business Machines Corporation (IBM).

IBM scientists Dr. P. P. Sorokin and Dr. M. J. Stevenson have developed a new approach to the generation of coherent light waves both in the visible and infrared portions of the electromagnetic spectrum. Coherent light waves are produced by synchronous and co-operative (in phase) oscillations of ions introduced into a crystal. The resulting light waves have a sharply defined frequency and propagate in an intense, highly directional beam.

Two new optical masers, or "lasers," based on the new approach have shown promise. Both emit intense beams of coherent light, one at 2.5 microns in the infrared or "invisible light" portion of the electromagnetic spectrum, and the other at 0.708 microns in the red portion of the visible spectrum. (Maser is an acronym for microwave amplification by stimulated emission of radiation.)

The IBM masers, which operate on about 1/500 the amount of power required by the ruby optical maser—the only previous one disclosed, constitute a new family of these devices because they are based on ions of rare earth and transuranic elements not previously used.

Communication by light waves has been a goal of many scientists. Use of the infrared and visible light portions of the spectrum will greatly increase the number of channels available for the transmission of information.

Such use of light waves has been impossible until now because there has been no device capable of generating continuous and coherent, single-frequency light waves. Inherent limitations in the material of the ruby optical maser restrict the output of that device to short pulses of about 1/1,000 second at widely spaced intervals.

Continuous generation of coherent light, possible for the first time with the IBM approach to optical masers, also offers some exciting possibilities in space exploration. To build an "optical lane" navigation system, which allows a plane or space ship to be guided to its destination, a device transmitting such waves would be desirable. It also shows promise for use in radar, data processing, control of chemical reactions, and in many other fields.

THIS is a close-up view of the new trivalent uranium maser through a window in the lower portion of a liquid helium dewar. When a light is flashed through the side port, the maser emits coherent light waves by the synchronous and co-operative (in phase) oscillations of trivalent uranium ions. The coherent light waves emitted by this maser, and a divalent samarium maser also announced recently by IBM, have a sharply defined frequency and propagate an intense, highly directional beam.

"Trivalent" uranium ions (so-called because three electrons are removed from the uranium atom's outer shell) are the key to the new infrared device; "divalent" samarium ions (two electrons are missing from the shell of the samarium atom) are the key to the visible red light maser. Both use a "hot lattice" of calcium fluoride, in which 0.1% of the calcium ions are replaced by uranium or samarium ions. Calcium fluoride is a commonly used optical material.

The trivalent uranium and divalent samarium ions are the key to continuous generation of coherent light because they successfully overcome the limitations of ruby as an optical maser material. This means that refinement of the new device approach depends primarily on improved optical design rather than on further advances in materials research.

For example, the beam angle of less than half a degree achieved with the first of the new masers may theoretically be reduced by several orders of magnitude. So sharp would such a beam angle be that over a distance of 100,000 miles the light waves would focus on less than a 1-mile-diameter surface, compared to a microwave transmitter which would scatter its radio waves over a 10,000-mile-diameter area.

The concept of optical masers was originally proposed in 1958 by Dr. A. L. Schawlow and Prof. C. H. Townes. A paper describing the trivalent uranium maser entitled, "Stimulated Infrared Emission from Trivalent Uranium," by Dr. Sorokin and Dr. Stevenson appears in the December 15 issue of the *Physical Review Letters*, a publication of the American Physical Society. Another paper by the two IBM scientists, "Solid State Optical Maser Using Divalent Samarium in Calcium Fluoride" appears in the January issue of the IBM *Journal of Research and Development*. **EE**

IBM scientists Dr. P. P. Sorokin (*left*) and Dr. M. J. Stevenson prepare for an experiment with the new trivalent uranium optical maser. Dr. Sorokin is using a screw driver to tighten the plate which attaches the maser crystal to a liquid helium dewar used to cool the maser down to the temperature of liquid helium (about —450 F). Dr. Stevenson (*right*) is putting a calcium fluoride crystal containing trivalent uranium into position and fastening a spring to hold it in place.

New Technique Enables Linemen To Work Safely with Bare Hands

Thanks to a new twist on an old idea borrowed from the birds, linemen of the American Electric Power (AEP) System are able to work in safety on a live high-voltage power transmission line with their bare hands.

The new technique of working with bare hands on an energized power line, now thoroughly field tested and about to be adopted as standard practice on AEP System lines, was announced recently by AEP President Philip Sporn. He described the method as "a truly outstanding development, one of the most important in its field in the history of the electric power industry," but warned that its use required special equipment and proper training to insure the linemen's safety.

The new technique is a simple one. It is the reverse of conventional practice and utilizes the principle that current does not flow when there is no difference in

voltage between two points. Heretofore, a lineman has performed his work while grounded and insulated from the live conductor by protective devices such as rubber goods and insulated hotsticks. With the new method, the lineman is charged at the same voltage as the line on which he is working—a phenomenon of which he is not even physically aware—and protected from ground by effective insulation.

It is the same way with birds. "They can perch on electric wires—even high-voltage lines—with nonchalance because they are not in contact with the ground," Mr. Sporn explained. "When they alight on a wire, they merely become charged or energized to the voltage of the line itself, and in this process they are not even hurt."

In emphasizing the significance of the development, Mr. Sporn pointed out four major benefits: (1) Further improvement of today's reliable electric service to customers by insuring service continuity through eliminating interruptions for line repairs; (2) Reduced line maintenance costs brought about by savings in both time and manpower; (3) Simplified working conditions, permitting linemen to work without cumbersome tools and equipment; (4) Greater safety in many cases than with the use of live line tools in conventional practice.

Here is how the new method works:

Linemen work while standing in a Fiberglas bucket hoisted to overhead wires by a truck-mounted insulated aerial boom. The bucket is lined with a metal mesh that is connected by clamps to the conductor on which the men are working, thus energizing the screen and the occupants at the same voltage as the line. Their safety is provided by the insulated boom which protects them from the difference in voltage between the ground and the live conductor.

H. L. Rorden, high-voltage practices engineer for the American Electric Power Service Corporation, New York, N.Y., developed the basic idea and supervised the research and testing. He was assisted in the development work by M. L. Fisher, of Canton, Ohio, transmission superintendent of the Ohio Power Company, an AEP System operating company.

Holan Corporation, Cleveland, Ohio, manufacturer of hydraulic derrick trucks and aerial lifts, and its parent company, The Ohio Brass Company, co-operated in the tests and supplied equipment. The laboratory work was carried out in the Ohio Brass High-Voltage Laboratory at Barberton, Ohio.

The new equipment is a real boon to linemen. For years they have worked on hot wires with special tools attached to long insulated poles, called hotsticks, and while hanging from wooden poles or steel towers by their safety belts. It was a difficult job made more difficult by cumbersome working procedures which were necessary for safety. Now linemen can stand in front of the line and work comfortably on it with their bare hands or wearing ordinary work gloves.

Savings in time will be major. For example, in conventional line work and under ideal conditions approximately 5 man-hours are required to change an insulator on a 34,500-volt wood pole line. With the new method this same job now takes but half a manhour.

Mr. Sporn disclosed that the new method for handling live conductors with bare hands had been thoroughly lab-tested at voltages up to 380,000 volts and also had been proved safe during extensive field tests. The latter tests were recently carried out on both a 138,000-volt steel tower transmission line and a 34,500-volt wood pole transmission line in the Findlay District of Ohio Power by an Ohio Power crew. The tests were witnessed by numerous engineering, operating, and safety officials assembled from various points on the 7-state AEP System. **EE**

Small TV Camera Tube Scans Ocean Bottom

Scanning uncharted depths on the ocean floor is the latest assignment for a small television camera tube which is frequently used in the telecasting of motion-picture films.

The tube, called a vidicon, is being employed as the "eye" in each of four television cameras installed on the U. S. Navy's new tank-like vehicle which crawls along the ocean bottom, D. Y. Smith, vice-president and general manager, RCA Electron Tube Division, reported recently.

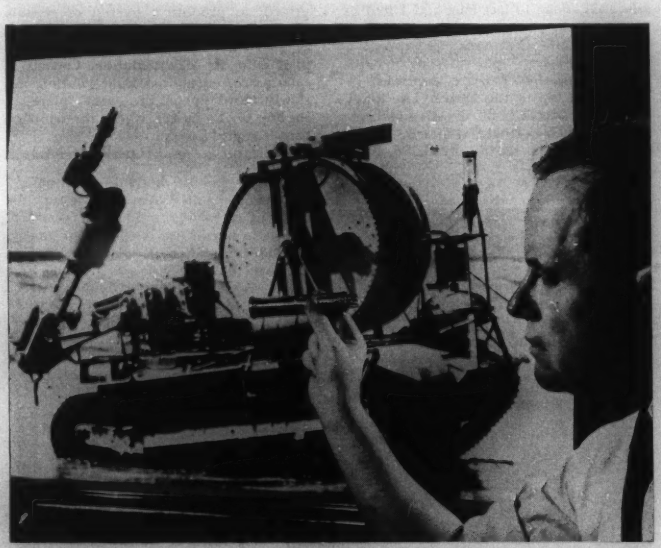
Mr. Smith stated that the small tube, designated *RCA-7038*, is only 6¼ inches long and about 1 inch in diameter.

"This tube gives 'sight' to the first device of its kind to be equipped with live TV cameras for deep-sea research work," he said.

The unusual vehicle, nicknamed RUM for "Remote Underwater Manipulator," has been constructed for the Office of Naval Research. RUM was developed by the University of California's Marine Physical Laboratory of the Scripps Institution of Oceanography. During the past summer, the giant electronic and mechanical vehicle received its first ocean tests. It is able to roam the ocean floor at 3 mph and may remain submerged for several months.

The camera tube and the associated camera equipment are housed in a special steel case which can withstand pressures at depths of 20,000 feet. Mercury vapor lamps, also enclosed in pressure cases, illuminate the dark underwater scenes up to 30 feet for the television cameras. Signals from these nautical television cameras, designed by Orbitran Company, Inc., of Lakeside, Calif., are relayed to a monitoring and control station on land via a 5-mile length of lightweight coaxial cable. Each camera is equipped with two remotely controlled motors for adjustment of iris and focus.

According to officials of the Marine Physical Laboratory, RUM has a capacity for six television cameras although only four units were used in recent tests. In a typical arrangement, four cameras would be mounted on the front, rear, and sides for general viewing of the underwater terrain. Two other television cameras would be installed on the 15-foot manipulator arm to provide a 3-dimensional view.



WITH this small RCA electron tube, the U. S. Navy's new tank-like vehicle (*background*) can see as it crawls along the ocean floor. The vidicon tube is employed as the "eye" in each of four television cameras installed on the unusual craft, first device of its kind to be TV equipped for deep-sea research. Signals from the nautical cameras are relayed to a control station on land via a special cable from the large reel. The vehicle, nicknamed RUM for "Remote Underwater Manipulator," was developed by the University of California's Marine Physical Laboratory of the Scripps Institution of Oceanography.

Laboratory personnel report that the mechanical arm and claw of RUM can lift 1,500 pounds and retrieve important marine specimens. They expect the television-equipped vehicle will permit a significant increase in underwater installation and exploration projects. **EE**

Synthetic Quartz Crystals For Communication Purposes

The world's first factory built to mass produce quartz crystals for communications purposes went into production on a commercial basis recently at the Merrimack Valley Works of the Western Electric Company.

The step marked the successful climax of more than 50 years of scientific experimentation and research. It also signified the emergence of the United States from dependence upon a foreign supply of pure quartz crystals. A strategic material, the crystals were in critically short supply during World War II.

Quartz crystals are used in radio and television transmitters, telephone communications, radar, and sonar. Previously, the only source for them has been the interior of Brazil, where mining of the fist-sized crystals required for communications is done by individuals on a free-lance basis, resulting in unstable supplies and high prices.

The new factory grows quartz crystals of superior size and quality in a sort of scientific rock garden, under tremendous pressure and fierce heat.

In the growing area, 20 cylindrical vessels, each about 10 feet long and 1 foot in diameter, are sunk below the surface of the floor. Into each vessel is lowered a long wire basket. "Seed" crystals of natural or artificial quartz are suspended in tiers at the top of the basket. The lower half of the basket is filled with small, inexpensive pieces of natural quartz. In this form, quartz is readily available from many sources but is unsuitable for communications purposes.

A PERFECT synthetic quartz crystal, grown at Western Electric's Merrimack Valley Works. In foreground are pieces of natural quartz.

To begin the growth cycle, a weak alkali solution is poured into the vessel, which is then sealed. A heavy steel shield is lowered over the top by a crane for additional protection.

The contents of the vessel are heated to a temperature of 700 degrees and the interior pressure reaches about 25,000 pounds per square inch.

It takes about 3 weeks of continuous growth to produce a harvest of crystals. Under heat and pressure, the small pieces of quartz at the bottom of the basket dissolve into the alkali solution. Crystals of quartz are redeposited from solution and slowly build up on the "seed" plates at the top of the basket, where the temperature is slightly cooler.

While quartz in a variety of forms is the world's most common mineral, the pure, colorless crystals required for communications cost about $30 a pound in the natural state. Imperfections found even in the best of natural crystals and waste from slicing operations result in a loss of about 97% of the material. This brings the cost of the quartz in the final plates used for electronic purposes to about $94 an ounce ($1,500 a pound). By comparison, gold costs $35 an ounce.

Only three technicians are required to operate the new factory's growing area, which is automatically controlled except for loading and unloading the crystal-growing vessels.

While scientists have been attacking the problem of making suitable crystals for half a century, it was only a few years ago that the hydrothermal process for making them was developed by Bell Telephone Laboratories. The achievement followed several years of research and experimentation after World War II.

In 1958, a pilot plant for converting the laboratory process to commercial production was established at the Merrimack Valley Works of Western Electric, the Bell System's manufacturing and supply company. Additional development work had to be undertaken by Western to solve other problems in converting the laboratory production.

In telephone work, quartz crystals are at the heart of equipment that permits many different telephone conversations to be carried simultaneously over the same circuit without interference. Quartz can also be used to regulate radio frequencies and as a source of ultrasonic waves. **EE**

Thermoelectricity May Be Used To Provide Navigation Aids

Thermoelectricity, one of science's most exciting new fields, may soon find application in a problem which goes back to the earliest recorded history—providing

A RACK of seed crystals are lowered *(left)* into a growing vessel at Western Electric's Merrimack Valley Works, North Andover, Mass. *Right:* Synthetic crystals are inspected as they emerge from the growing vessel, 3 weeks after they were sealed inside.

A thermoelectric generator built by Minnesota Mining and Manufacturing Co., which converts energy from propane fuel directly into electric power without moving parts, is one of the devices being studied by the U. S. Coast Guard as a possible replacement to the battery systems now used to power lights, such as the one at left, in buoys and other navigational aids.

Minnesota Mining and Manufacturing Co. photo

effective navigation aids to maritime vessels. Significant savings to the American taxpayer could result.

A 10-watt propane-fueled thermoelectric generator was recently delivered to the U. S. Coast Guard by Minnesota Mining & Manufacturing Co. (3M) as part of a feasibility study on the use of thermoelectric power in lighted buoys and other navigation aids. Other devices are also under study.

While the principles of thermoelectric generation (producing current by heating a junction of two dissimilar materials, without any moving parts) have been known for more than a century, it was not until very recently that materials were developed which make it possible to apply the principle to problems such as aids to navigation, which have been a concern since the Pharos lighthouse at the entrance to the harbor of Alexandria became one of the wonders of the ancient world.

R. W. Fritts, head of 3M's thermoelectric program, said that if a feasible thermoelectric system can be developed, it would provide up to five times as much power for these navigation aids, coupled with a substantial reduction in the cost of operating the devices.

Most United States buoys and other minor navigation aids are now battery powered, delivering about 10 watt-hours for each pound of batteries. By contrast, the 12-volt generator delivered to the Coast Guard will deliver 200 watt-hours for each pound of propane fuel. While present costs range from $6 to $10 per kilowatt-hour (from $33 to $504 a year for each buoy depending on the size) the fuel cost of a thermoelectric generator would be about 15¢ per kilowatt-hour, said 3M, and although precise costs for a complete thermoelectric system cannot be calculated until additional data is available, the total cost of a thermoelectric system would be only a small fraction of the cost of present devices

The Coast Guard hopes to develop a system which will provide uninterrupted power, without maintenance, for a 2-year period. At present, buoys are taken from the water at least once a year, but if a power supply of sufficient capacity were available, the buoys could be left in the water unattended for a period of at least 2 years, according to Coast Guard officials. This in itself would result in very significant savings.

Coast Guard officials indicated that if the first feasibility studies are successful, they hope to procure more advanced prototype models for actual field testing. The first units will probably be used for the operation of minor shore lights, where their operations can be checked periodically and where there is a more pressing need for brighter lights. If shore use shows that thermoelectric power supplies are completely reliable for long term use, they may be tried on buoys at a later date.

EE

Fluorosint Replaces Teflon, Kel-F in Tunable Stalos

Material evaluation was one of the major problems facing the engineers of Pitometer Log Corp., New York, N. Y., during development of S-band stable local oscillators (tunable stalos). Vibration, heat generation, and extreme electronic precision placed very restrictive conditions on the materials to be used. A formal testing program was started for both laboratory and prototype evaluation.

Of six materials tried, the three that rated prototype investigation were: (1) Teflon (TFE), (2) Kel-F, and (3) Fluorosint, a new TFE fluorocarbon composition developed by The Polymer Corporation, Reading, Pa. Fluorosint consists of basic TFE plus other constituents designed to improve TFE's mechanical and thermal properties without materially affecting TFE's unique electrical and chemical characteristics. How well these properties solve a specific problem is the concern of the electronic design engineer.

Pitometer Log engineers originally started their investigation with five plastics that they felt had possibilities for their application. These were: polyethylene, polystyrene, cross-linked polystyrene, Teflon and Kel-F. The sixth material—Fluorosint—was added to the group for consideration after the initial parts were tried. A screening by both calculations and specific tests quickly reduced the original five materials to two—Teflon and Kel-F. Factors considered and tested in the original screening were usable temperature range, mechanical stability, thermal expansion, and electrical characteristics such as dissipation factor and dielectric constant at uhf frequencies.

The major problem was in the feedback assembly, which is a clamping and positioning device to locate the power tube. Two parts were particularly critical—the grid flange clamp and the feedback spacers. The grid flange clamp positions the tube laterally while the feedback spacers locate the tube axially.

History of the Grid Flange Clamp. This clamp is a 0.320-inch-thick 1½-inch-diameter disc. It is compressed between a segmented clamp and an aluminum ring. Obviously, any creep or cold flow of the material would change the precise location of the tube in relation to the remainder of the assembly. Being aware of Teflon's low resistance to deformation, Pitometer engineers tried Kel-F in this application. In laboratory tests, they found that the power loss was much too high since Kel-F's high dissipation factor (approximately 0.009) created as much as 50% power loss. Therefore, despite the obvious drawbacks to the mechanical properties of Teflon, it was used in field-tested prototypes.

Operating temperatures proved to be another problem. Temperatures inside the tunable stalos were from 105 to 110 C. In this temperature range, the linear coefficient of thermal expansion of Teflon is 8 times that of the aluminum mounting plate. This resulted in distortion of the Teflon to such an extent that the parts could not be reassembled properly after a tear down.

Fluorosint, a far more rigid material, was then tried for the grid flange clamp with successful results. The coefficient of thermal expansion of Fluorosint is practically identical with that of aluminum. Therefore, there is no problem of distortion due to temperature build-up. Electrically, the dissipation factor of Fluorosint is approximately one-tenth that of Kel-F (0.0005–0.001 compared to 0.009, respectively). And, although Fluorosint's dissipation factor is slightly higher than Teflon's, the difference in power loss between the Teflon and the Fluorosint grid flange clamp is insignificant. Fluorosint's usable frequency range is up to 10,000 mc, which is basically the same as that of unmodified Teflon.

History of Feedback Spacers. Teflon could not be used for these spacers despite its excellent electrical characteristics. Considerable pressure is applied to the feedback spacers. A threaded bolt goes through the center of the spacer and screws into the locating flanges of the tube. Kel-F was used initially to get the necessary rigidity. Field tests showed that the power loss was excessive, just as it was with the grid flange clamp. After testing Fluorosint for the grid flange clamp, spacers were machined from Fluorosint rod and inserted in place of Kel-F during periodic overhaul of the prototype models.

After successful testing, the engineers also specified Fluorosint for the coil form. This 9/16-inch-diameter by 7/8-inch-long part acts as a mechanical spacer and insulator. No redesign of the parts was necessitated by the change of material as the dielectric constants of the two materials are similar.

The production department reports that the Fluorosint is much easier to machine than Teflon. Higher machine speeds are possible and closer tolerances can be held. The conclusion that Pitometer engineers have drawn from their collection of data and experience is that Fluorosint demonstrates a vast improvement in the mechanical and thermal properties of the TFE with only minor changes from TFE's electrical characteristics. EE

Azusa Mark II System Developed for Air Force

A $10 million advanced missile tracking system, designed and built by Convair (Astronautics) Division of General Dynamics Corporation, has been placed in use by the U.S. Air Force Missile Test Center, Cape Canaveral, Fla., J. R. Dempsey, vice-president of Convair and division manager of Convair-Astronautics, reported recently.

This precision electronics system, called the Azusa Mark II, permits the Air Force to track missiles fired down the Atlantic Missile Range (AMR) and to predict their impact points.

It could also be used to calculate satellite rendezvous points in space, track orbiting space vehicles, or determine interception points for satellite-to-satellite test and recovery missions.

Convair conceived and built the earlier Azusa Mark I system, which has been in operation at Cape Canaveral since 1954, and builds the Azusa transponders (receiver-transmitters) which are installed in virtually all ballistic missiles and space boosters launched at AMR.

"The earlier system was the most accurate in existence at the time it was developed," S. L. Ackerman, director of electronic products for Convair-Astronautics, said. "The advanced system, which has been under development five years, is expected to contribute materially to the nation's capabilities for missile and space research."

The new system employs the same phase-comparison principles as Mark I.

The Azusa Mark II system can depict instantly to a range safety officer the impact point of any missile, if its engines should stop during flight. Immediately after test shots, engineers can determine the exact speed and location of the missile at any time in the flight by studying data recorded by the Mark II system. This is especially valuable in checking the performance of the missile's guidance and propulsion systems.

The Mark II ground equipment tracks a missile by transmitting radio signals to a small airborne transponder which beams a continuous signal back to earth. In an electronic "wink of an eye" this signal is captured by the Mark II's nine parabolic receiving antennas on the ground, then sped into a computing system. This information is converted into data which shows the missile's flight progress on a large plotting board.

Ten tracking antennas—"all-weather eyes" of the system—are located within a quarter-mile of the Azusa operations building in small, air-conditioned structures which rest on thick, concrete slabs.

The operations building contains a control room, office area, maintenance room, air-conditioning equipment, store room, and 22 equipment cabinets filled with more than 5,000 vacuum tubes, 9,000 semiconductors, and 40 miles of cable. The entire system, including antennas and equipment cabinets, has some 100,000 electronic parts. The "brain" of the tracking system is an IBM *709* computer.

The entire Mark II system was pretested at Convair-Astronautics' plant in San Diego, Calif., then shipped to Cape Canaveral in August 1959, for installation and an extended checkout program.

Reliability has been high, it was stated. During the last 6 months of checkout the average operating time on each of the missile tracking system's 15 electronic subsystems was 1,668 hours, and no system was inoperative for more than 7 hours during this period. No malfunction occurred during actual tracking tests with aircraft.

The Azusa Mark I system is scheduled for retirement in mid-1961.

Technically, the Mark II system has increased accuracy capabilities of 10 parts per million in direction cosine and 10 feet plus 5 parts per million range accuracy. Increased resolution by means of additional antennas 500 meters from the basic Azusa reference antennas were utilized to increase the cosmic resolution to 0.2 part per million in direction cosine. Increased resolution by means of coherent carrier equipment is 0.1 foot. EE

Ephi Locates And Analyzes Sferics

A new and versatile tool for the investigation of electromagnetic waves which originate from lightning discharges ("sferics") has been developed by the National Bureau of Standards (NBS) at Boulder, Colo.

"Ephi," the name for this new system which locates and analyzes sferics, is capable of appreciably greater accuracy than direction-finding systems which have been used in the past.

The experimental equipment for the Ephi system has been installed near Brighton, Colo. (about 20 miles northeast of Denver's Stapleton Airfield) by a group of NBS scientists headed by Gifford Hefley.

Three 125-foot vertical antenna towers

INSIDE this cluster of white radomes at Cape Canaveral, Fla., (above, *left*) a battery of precision antennas now enables Air Force to track missiles with accuracy of a few feet at hundreds of miles. It is the Azusa Mark II system, installed by Convair (Astronautics) Division of General Dynamics Corporation, which also invented the earlier Azusa Mark I, in use at the Atlantic Missile Range since 1954. Above, right: A modern, air-conditioned control room is the center of the Azusa Mark II missile tracking system.

are spaced about 4 miles apart, forming the vertices of an equilateral triangle. Except for the rare case when a storm is occurring at the exact center of this triangle, a sferic radio signal (it would be called "static" by most radio listeners) will reach each antenna at a slightly different time. The signals received at each antenna are fed over coaxial cable to the central control station of the system, which is located in what was once the teachers' living quarters at the old Whittier school. Here electronic equipment determines the relative difference in time of arrival of the sferic signal from each antenna, and, from this, the direction from the schoolhouse to the lightning source is automatically determined.

Since sferics travel with the speed of light (approximately 186,000 miles per second) and the antennas are so closely spaced, the differences in time of arrival at the three antennas are so small that they are measured in microseconds. The maximum difference in arrival time between the antennas at Brighton is only about 21 microseconds. The Ephi equipment is able to make such measurements of time difference with an accuracy of a small fraction of a microsecond.

In addition to determining the direction of arrival of sferic signals, the equipment in the old schoolhouse at Brighton counts the total number of sferics occurring in any desired time interval, and can count the number of sferics arriving from several different directions at the same time. The sferic waveform can also be photographed, either with still or motion-picture cameras, and retained for further detailed studies aimed at a better understanding of radio wave propagation as well as the nature of the lightning itself.

In addition to its value as a research tool, Ephi is potentially of value in tracking such severe weather phenomena as tornados and hurricanes.

The Ephi station at Brighton can pick up sferic signals originating in storms far offshore in the Gulf of Mexico or the Atlantic ocean. Two such stations, located a few hundred miles apart, could accurately "fix" the position of a storm at distances of many hundreds of miles from either station. **EE**

Navy Missile Ships Get 3-Dimensional Radar

Modern missile-armed cruisers and destroyers of the U. S. fleet have been equipped with the first seaborne electronic scanning radar capable of pinpointing simultaneously three essential target dimensions—range, bearing and altitude—to retaliate against enemy airborne attack, it was announced recently.

The U. S. Navy and Hughes Aircraft Company said that "Frescan," a powerful, lightweight, all-weather radar, uses only a single antenna, transmitter, and receiver and automatically flashes information on supersonic targets to information and control centers that fire interception Talos, Terrier, or Tartar missiles.

Conventional radar systems, Navy and Hughes officials said, generally require

TOWERING more than 140 feet above the water on a masthead of the missile cruiser *USS Galveston*, antenna of new Frescan radar system simultaneously detects range, bearing, and altitude of multiple aircraft at lightning speeds. Developed and produced by Hughes Aircraft Company, the lightweight, powerful antenna is electronically stabilized, allowing it to pitch and roll with ship and eliminating heavy masthead weight of conventional radar. Single antenna replaces two or more previously required. Sailor is posed on platform only to show comparative size of antenna.

combinations of several antennas, transmitters, or receivers to provide 3-dimensional target information, and also heavy, mechanical gyro-stabilizing equipment to compensate for pitch and roll of a ship at sea. Frescan does not.

"Frescan concentrates all available power in sharp, pencil-shaped beams of energy to pinpoint targets at great distance and with extreme accuracy," Mr. Brubaker said.

Range and height information is obtained by electronic scanning in a vertical plane in milliseconds while rapid rotation of the antenna supplies target bearing.

The Frescan antenna is affixed to the masthead and allowed to roll and pitch with the ship.

Electronic stabilization assures accurate information no matter at what angle the antenna is located.

Roll and pitch signals from a ship's main gyro are supplied to a Hughes-developed computer which instantly and automatically modifies the elevation beam scanning program and presents the true position of targets on the radar scopes.

Elimination of heavy mechanical stabilization equipment reduces topside weight and contributes to the ship's stability. For example, some above-deck equipment is up to 20 times greater than Frescan's weight of about 2,800 pounds.

The system provides a high degree of flexibility, both in operation and application and provides desired target coverage at a maximum data rate.

The Navy and Hughes pioneered the development of 3-dimensional radar with the company delivering the first prototype equipment to the Bureau of Ships in August 1957. The frequency scanning technique was developed by Dr. N. A. Begovich, assistant manager of the Fullerton facility, after many years of basic research.

The Frescan radar system is an example of joint service co-operation. A direct result of the Navy's pioneering effort is Frescanar, a U.S. Army 3-dimensional electronic scanning radar. Frescanar serves as the "eyes" of Missile Monitor, a mobile air defense fire distribution system for use with a field army—now deployed in Europe.

Ships now equipped with Frescan include the Navy's newest missile cruisers, *USS Galveston*, *Springfield*, and *Providence*, the missile destroyer-leader *Dewey* and others. **EE**

New Electrolytic Machining Process

An electrolytic machining process that can shape parts from the toughest alloys in as little as one tenth the time of conventional machine tools has been developed by Battelle Memorial Institute in research supported by the Steel Improvement and Forge Co., Cleveland, Ohio.

Metal is removed without arcs, sparks, or high temperatures by passing direct current between the workpiece and an electrolyte. The current removes electrons from the workpiece, converting the surface atoms into positively charged ions that dissolve into the electrolyte. This process is unique in that its effectiveness is not dependent on the hardness of the metal and, thus, offers a solution to the problem of machining the harder, higher-strength metals.

To produce a part, a rough forging or piece of metal stock (anode) is placed between shaped electrodes (cathode) and electrolyte is pumped under pressure into the space between the electrodes and the workpiece. As the electric current dissolves

the workpiece to the desired shape, the electrodes are moved in simultaneously.

The electrolytic unit has machined rough forged jet turbine blades to 0.003-inch tolerances in 5 to 10 minutes—an operation which took from 1 to 2 hours to perform by grinding. In addition to shaping parts, other types of units can be used to sink die cavities in 50 minutes which previously required 7 to 10 hours of machining time. They also can drill round and irregularly shaped holes in alloys that cannot be penetrated by conventional drills. For some applications the process's big advantage is not the time saved but the absence of mechanical damage to the surface of the workpiece.

Because there is no tool pressure on the workpiece, very thin sections can be shaped without deformation and lightweight machines and clamping systems can be used. Also, the shaping process produces no metallurgical change on the surface of the workpiece as conventional machining does.

The development of the electrolytic machining process is the result of over 2½ years of work by a Battelle research team which included Dr. C. L. Faust, chief of electrochemical research at the Institute; Dr. J. A. Gurklis; and J. E. Clifford.

According to Dr. Faust, the Battelle-developed process differs from others which use the electrolytic metal removal principle in that: (1) it can produce complete parts in addition to sinking cavities, (2) it uses no rotating cutting wheels, (3) power is supplied through a simple rectifier instead of complex electronic circuits.

Current requirements for the electrolytic machining process range up to 1,500 amperes per square inch of workpiece at 3 to 12 volts, to achieve a penetration rate of 0.05 to 0.1 inch per minute. However, for most operations, 100- to 500-ampere current is sufficient. The shaped electrodes, which are not subject to wear, can be made of any electrically conductive material. The electrolytes, selected according to the metal to be machined, are solutions of readily available commercial chemicals. EE

Sensitive Infrared Scanning Device

Development of an infrared scanning device so sensitive that it forms a man's picture merely by picking up heat emitted from his body was announced recently by the Electronics and Ordnance Division, Avco Corporation. Called Avscan, the new device may be used to detect enemy missiles or airplanes.

Jet aircraft or aerodynamically heated objects, such as a missile nose cone, can be detected at very long range. The hotter the object the better Avscan is able to pick it up.

The Avscan unit consists of four major components—a scanning head, a signal processing unit, a display unit and a cryogenic cooling supply. Electronics parts of the system are transistorized, with plug-in type modules for easy serviceability. EE

NEW BOOKS

The following new books are among those recently received at the Engineering Societies Library. Unless otherwise specified, books listed have been presented by the publishers. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books in question.

ADVANCES IN X RAY ANALYSIS, Volume 3. Edited by W. M. Mueller. Plenum Press, 227 W. 17th St., New York, N. Y., 1960. 376 pages, 6 by 9¼ inches, bound. $12. This volume contains 23 of the papers presented at the 8th annual conference on applications of X-ray analysis, held in Colorado in August 1959, and sponsored by the Denver Research Institute of the University of Denver, and two papers from the 7th conference. The papers discuss developments in the fields of X-ray absorption, fluorescence, diffraction, and instrumentation.

ANALOG AND DIGITAL COMPUTER TECHNOLOGY. By N. R. Scott. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N. Y., 1960. 522 pages, 6¼ by 9¼ inches, bound. $12.75. This introductory text, an outgrowth of a University of Michigan graduate course, is intended for use by electrical engineers. The first four chapters deal with the direct-coupled electronic differential analyzer (analog computer), and the last seven with the digital computer. In each section applications are covered first, followed by discussion of engineering design and technology.

ANALOG COMPUTATION IN ENGINEERING DESIGN. By A. E. Rogers and T. W. Connolly. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N. Y., 450 pages, 6¼ by 9¼ inches, bound. $16. Emphasizing application rather than design and operation, this book demonstrates the use of the general-purpose analog computer in the solution of industrial problems. The brief introduction describes the principles, capabilities, and limitations of the computer. There follows a concise review of pertinent topics from engineering mathematics, and a full treatment of computer methods of solution. The final section is an analysis of real problems taken from industry, illustrating efficient problem preparation and computer solution.

BASIC ELECTRICAL MEASUREMENTS. By M. B. Stout. Second edition. Prentice-Hall, Inc., Englewood Cliffs, N. J., 1960. 571 pages, 6¼ by 9¼ inches, bound. $8.75. This undergraduate text selects the measurement methods that are most imporant and most frequently used today, omitting special procedures and those now mainly of historical interest. Generally modernized, this edition also includes discussion of new elements such as standards of capacitance based on Lampard's theorem; microvolt potentiometers, resistance strain gauges and new voltage standards; and Hall elements, both for magnetic measurements and as multiplying devices. A chapter on electrical indicating instruments is included.

BASIC PROCESSES OF GASEOUS ELECTRONICS. By L. B. Loeb. University of California Press, Berkeley, Calif., 1960. 1028 pages, 6¼ by 9½ inches, bound. $13.50. This is not a new edition of the author's Fundamental Processes of Electrical Discharge in Gases," although it follows much the same general outline. Except for topics of a classical nature in which few changes have occurred, the book contains almost entirely new material. It discusses ionic mobilities; the diffusion of carriers, velocities of electrons, and the distribution of energy of electrons, in a gas; the formation of negative ions and the recombination of ions; electrical conduction in gases below ionization by collision; and ionization by collision of electrons in a gas, involving Townsend's first and second coefficient.

CONTROLLED THERMONUCLEAR REACTIONS. By S. Glasstone and R. H. Lovberg. D. Van Nostrand Co., Inc., 120 Alexander St., Princeton, N. J., 1960. 523 pages, 6¼ by 9¼ inches, bound. $5.60. This is a survey of basic principles and current research into the production of controlled energy from nuclear fusion. Discussion of the physical conditions necessary for the possible methods of achieving fusion is followed by description of the properties, the techniques of studying the properties, and the methods of production of plasmas of thermonuclear interest. Research on the pinch effect, the Stellarator, magnetic mirror systems, the Astron concept, and other proposed methods for plasma heating and confinement is then reviewed, and the book concludes with a survey of sources of energy loss from heated plasmas and an outline of plasma stability theory.

COMPUTER ENGINEERING. Edited by S. A. Lebedev. Pergamon Press, 122 E. 55th St., New York 22, N. Y., 1960. 184 pages, 5½ by 8¼ inches, bound. $10. This translation from the Russian contains papers discussing the power supply of the high-speed electronic computer of the Academy of Sciences of the USSR; new elements and units for computers; a method of control of the arithmetic unit; a method of electing the required word from the dictionary in machine translation; and present-day computer technology. The original publication was drawn up by specialists in the design and operation of electronic computers.

COUPLED MODE AND PARAMETRIC ELECTRONICS. By W. H. Louisell. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 1960. 268 pages, 6 by 9¼ inches, bound. $11.50. This introduction to the theory of coupled modes shows how the use of the theory simplifies the study of coupled systems. From this point of view, it also presents a unified theory of traveling wave tubes, backward wave oscillators, and similar microwave devices, and discusses the theory of parametric amplifiers, oscillators, and frequency converters.

FUNDAMENTALS OF SIGNAL THEORY. By J. L. Stewart. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N. Y., 1960. 346 pages, 6¼ by 9¼ inches, bound. $9. This book is concerned with the mathematical concepts and techniques of value in the analysis of linear and time-variant physical systems. Extensive consideration is given the steady state interpreted through the pole-zero diagrams in the first five chapters. Operational methods are introduced in chapter 6, and subsequently concepts in Laplace and Fourier transforms are considered with the aid of techniques of contour integration.

HANDBOOK OF LAPLACE TRANSFORMATION. By F. E. Nixon. Prentice-Hall, Inc., Englewood Cliffs, N. J., 1960. 115 pages, 5½ by 8¼ inches, bound. $6. The first two sections of this handbook deal with determinants, root finding methods, and Routh's criterion. Section 3 conains the derivation of many Laplace transform theorems. Section 4 describes identities, section 5 illustrates by examples the use of the Laplace transform method, and the final section is an extensive table of Laplace transform pairs.

MCGRAW-HILL ENCYCLOPEDIA OF SCIENCE AND TECHNOLOGY. Edited by W. H. Crouse and others. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N. Y., 1960. 15 volumes, 7½ by 10¼ inches, bound. $175. The more than 6 million words, and approximately 10,000 illustrations, drawings, charts, tables, etc., in this unique set of 15 volumes are grouped under some 7,200 subject headings of moderate scope to bring together closely related subject matter. Numerous cross-references refer to other related sections. A detailed subject index of more than 100,000 entries occupies 434 pages of volume 15, which also identifies members of the Editorial Advisory Board, the 63 consulting editors, and the 2,100 contributors who wrote material in the set. All fields of science and technology are covered on a level generally suitable for undergraduate college students, and for the serious-minded layman and some high school students especially interested in science and technology. It is not likely to help appreciably any engineer or scientist in his own special field, but it should often be useful to him as a ready reference source of information in other fields

with which he is less familiar. All sciences—life, physical, and earth—are covered, as are major applications in technology and engineering in the basic fields such as chemical, civil, electrical, mechanical, metallurgical, mining, and petroleum, and their various branches. Bibliographical references are given for many subjects.

MATERIALS IN NUCLEAR APPLICATIONS. Published as ASTM Special Technical Publication 276 by the American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa., 1960. 344 pages, 6 by 9¼ inches, bound. $8.25. This volume contains papers presented at four symposia held during the Third Pacific Area National Meeting ASTM in San Francisco, Calif., October 1959, and a literature survey of the title subject "Radiation Effects in Steels." The symposia fields are: radiation effects and dosimetry (14 papers); postirradiation effects in polymers (5 papers); technical developments in the handling and utilization of water and industrial waste water; industrial water for reactor use (2 papers); ceramics in nuclear energy (6 papers).

ELECTRICAL ENGINEERING PROBLEMS. By E. M. Williams and F. J. Young. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N. Y., 1960. 294 pages, 6¼ by 9¼ inches, bound. $7.75. These are problems selected from those given in sophomore-to-senior courses at the Carnegie Institute of Technology emphasizing laboratory problem-solving disciplines, which for their solution require professional skill in the application of electrical science and in the planning and conduct of electrical laboratory work. The problems are fully stated for utilization in student instruction, but no answers are given.

ELECTRICAL NOISE. By W. R. Bennett. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N. Y., 1960. 280 pages, 6 by 9¼ inches, bound. $10. A series of five articles written in 1956 for *Electronics* magazine has been expanded by inclusion of basic facts about the measurement of electrical noise, and the design of circuits in which noise effects are minimized. A development of the theory of noise, based primarily on the response of tuned circuits, and derivation of the properties of the noise sources, is presented without involving complicated mathematics. A succeeding chapter introduces the more advanced mathematical concepts of the theory of noise, and leads into the final chapter, which explores the intricate relationships of signal and noise in various types of communication systems.

ELECTRONICS AND NUCLEONICS DICTIONARY. By N. M. Cooke and John Markus. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N. Y., 1960. 543 pages, 6¼ by 9¼ inches, bound. $12. This illustrated dictionary gives definitions, abbreviations, and synonyms for over 13,000 terms used in television, radio, medical, industrial, space and military electronics, avionics, radar and nuclear science and engineering. Actually a second edition of "Electronics Dictionary" (1945), it bears little resemblance to its predecessor, showing vast changes in meanings of the old terms, addition of many new terms, and interlocking of the terminologies of nucleonics and electronics. It consistently adheres to common usage and standardization by engineering organizations in controversial cases, so that it becomes, in effect, a style guide also.

FIELD THEORY OF GUIDED WAVES. By R. E. Collin. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N. Y., 1960. 606 pages, 6 by 9½ inches, bound. $16.50. Presenting a comprehensive account of guided-wave theory at the graduate level, the emphasis is on field solutions, but sufficient material on microwave circuit theory is included to make clear interpretation of field solutions in terms of equivalent circuits possible. The mathematical techniques and solutions of the more elaborate wave guiding structures, waveguide discontinuities, antennas, and coupling apertures are also presented.

FOUNDATIONS OF ELECTRODYNAMICS. By Parry Moon and D. E. Spencer. D. Van Nostrand Company, Inc., 120 Alexander St., Princeton, N. J., 1960. 314 pages, 6 by 9¼ inches, bound. $9.75. This is an undergraduate engineering text presupposing knowledge of electricity and magnetism as taught in college physics. The treatment is nonrelativistic, and field theory is handled on a macroscopic basis, introducing the concept of polarization and magnetization only in the chapter on moving media. Topics covered include basic concepts, fields, Maxwell's equations, charges with and without relative motion, accelerated charges, skin effect, waves and waveguides, and antennas. The final chapter investigates relativistic electrodynamics.

FREQUENCY-POWER FORMULAS. By Paul Penfield, Jr., John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 1960. 168 pages, 6 by 9¼ inches, bound. $4. This monograph is a report on an attempt to find necessary and sufficient conditions for a physical system to obey the frequency-power formulas. In part one are described various energy function methods, and four types of frequency-power formulas, including the Manley-Rowe formulas. These four are also tabulated, along with other important information, in the appendices. In part two specific systems are considered—lumped dissipative, lumped reactive, and distributed systems. The final part discusses rotating machine applications and communications applications.

AMERICAN POWER CONFERENCE, PROCEEDINGS, 1960. Published by the Illinois Institute of Technology, Chicago 16, Ill. 1960. 869 pages, 6¼ by 9¼ inches, bound. $10. The annual American Power Conference is concerned with practice rather than theory, and a broad over-all view of problems of interest to the power industry and associated groups. Six topical sessions were held at the 1960 meeting. Papers presented at the general sessions deal with national considerations such as American economic power, national strategy, nuclear propulsion in the Navy, and the challenge of new power sources such as magneto-hydrodynamic generation, isotopic heat and power, and space-vehicle propulsion. Nuclear power plants are discussed in the nuclear power sessions papers; steam generators and turbines, peaking and central station power plants and auxiliaries, condensers, fuels, industrial plants, traction vehicle power and space heating in the mechanical sessions papers; turbine-generators, high-voltage systems, switching, distribution, communications and protection control, computers and network analyzers, and system planning and operation in the electrical sessions papers. The final two sessions deal with hydroelectric power–rates, revenues, and new project financing; and water technology—analysis and pollution control in industrial waters, and sea water conversion.

ATOMIC RADIATION AND POLYMERS. By A. Charlesby. Pergamon Press, Inc., 122 E. 55th St., New York 22, N. Y. 1960. 556 pages, 5½ by 8¾ inches, bound. $17.50. The method used here is to review and summarize published experimental material and then discuss underlying theories. Following a general introduction, the discussion deals with the interaction of radiation and matter, radiation sources, dosimetry, and the general properties of long chain polymers. The central part of the book summarizes existing data on radiation-induced changes in simple organic molecules and irradiated polymers, and those changes in which a chain reaction is involved. The final chapters discuss in a more theoretical manner the various reactions which may occur between initial irradiation, and final chemical change.

COMPARATIVE EFFECTS OF RADIATION. Edited by Milton Burton and others. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 1960. 426 pages, 6 by 9¼ inches, bound. $8.50. This book is a report on comparative effects of ionizing, ultraviolet, visible, and near-infrared radiations as they were examined and interpreted by a group of biologists, chemists, and physicists at a February 1960 Conference held at the University of Puerto Rico, jointly sponsored by the National Research Council, the National Science Foundation, and the Atomic Energy Commission. In 14 chapters, each a seminar on a particular topic, and a summary chapter, such topics as plant growth control, photo-reactivation, molecular photochemistry, effects on biological and chemical systems, excitation transfer and energy-transfer processes, irradiated polymers, and radiation chemistry of water, are discussed.

Library Services

ENGINEERING Societies Library books, except bibliographies, handbooks, and other reference publications, may be borrowed by mail by AIEE members for a small handling charge. The Library also prepares bibliographies, maintains search and translation services, and can supply a photoprint or a microfilm copy of any item in its collection. Address inquiries to R. H. Phelps, Director, Engineering Societies Library, 29 W. 39 St., New York 18, N. Y.

COMPUTER LOGIC. By I. Flores. Prentice-Hall, Inc., Englewood Cliffs, N. J., 1960. 458 pages, 6¼ by 9¼ inches, bound. $12. This book considers computers first at the over-all or highest levels of organization and proceeds later to lower levels of detail, emphasizing the organization and functional interrelationships of the fundamental units, which are discussed from the point of view of operational necessity. Minimum engineering and mathematical background is required to learn from this book how computers are put together, how they work, and how to use them.

EINFÖHRUNG IN DIE KORNGRÖSSEN-MESSTECHNIK. By W. Batel. Springer-Verlag, Berlin, West Germany, 1960. 156 pages, 6½ by 9½ inches, bound. DM 27. In this systematic presentation of research in the field of particle-size measurement, topics treated include sampling, measurement techniques for size and frequency determinations, the significance of particle size, aerosols, dusts, etc. Methods are given for determining surface and other physical characteristics of granular materials. The final chapter contains examples for the application of particle analysis.

HIGH VOLTAGE DIRECT CURRENT POWER TRANSMISSION. By Colin Adamson and N. G. Hingorani. Garraway Limited, London, England, 1960. 284 pages, 7½ by 10 inches, bound. $14. Much has been written on the subject since the early days of electrical power. This book has sifted, and sums up this literature, fortifying it with new material. Topics covered include converter circuits and valve connections; bridge rectifier and invertor parameters; grid control; compounding and regulation; commutation, harmonics, insulators, and corona; mercury arc valves; and d-c cables. A list of 225 references is included.

INDUSTRIAL ELECTRIC FURNACES AND APPLIANCES. By V. Paschkis and John Persson. Second edition. Interscience Publishers, Inc., 250 Fifth Ave., New York 1, N. Y., 1960. 607 pages, 6¼ by 9¼ inches, bound. $24. The original 2-volume edition has been consolidated into one volume, and much of the material revised. The five chapters are detailed discussions of individual topics, the first dealing with thermal problems, electrical laws, and economic considerations. The remaining chapters discuss arc furnaces, resistance furnaces, induction and dielectric heating, and selection of furnaces for specific applications.

INTERNATIONAL CONFERENCE ON NUCLEAR STRUCTURE, PROCEEDINGS. Edited by D. A. Bromley and E. W. Vogt. University of Toronto Press, Toronto, Ont., Canada, 1960. 990 pages, 6¼ by 10 inches, bound. $16.75. Nearly 500 scientists from all over the world attended the conference held in Kingston, Ont., in August-September, 1960. Three hundred research contributions were received at conference headquarters. Just five weeks after the conference this volume was published, containing 127 of the papers received, and a list with abstracts of all of the contributions. The topics covered by the published papers include the physical foundations of nuclear models, properties of nuclear matter, nuclear reaction mechanisms, properties and statistics of nuclear levels, and fission.

THE INTERNATIONAL DICTIONARY OF APPLIED MATHEMATICS. Published by D. Van Nostrand Company, Inc., 120 Alexander St., Princeton, N. J., 1960. 1173 pages, 7½ by 10¼ inches, bound. $25. This dictionary defines terms and describes methods in general and fruitful use in the applications of mathematics to 31 fields of science and engineering, and also defines terms from other fields which have been used in the definitions and descriptions of the applied mathematics concepts and methods. The 59 contributing editors are specialists in the 31 fields in Canada, Great Britain, Belgium, Australia and the United States. A useful feature is the group of four language indices listing alphabetically the French, German, Russian, and Spanish terms with the English equivalent, compiled by four translators, three from American universities, and the fourth the editor of *Soviet Physics*.

MODERN NUCLEAR TECHNOLOGY; A SURVEY FOR INDUSTRY AND BUSINESS. Edited by M. M. Mills and others. McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36, N. Y., 1960. 336 pages, 6¼ by 9¼ inches, bound. $9.50. The material in this book, drawn from 1956-57 survey courses at the University of California, is in the form of papers (lectures) by experienced practitioners dealing with nuclear energy fundamentals, safety measures, applications, and future outlook. The material is basic, concerned with fundamentals not substantially altered by time, and, as the subtitle infers, it is intended to help management personnel understand some of the problems inherent in nuclear engineering programs. Basic engineering principles and engineering methods of problem solution are not discussed, as the intended audience is assumed to have an engineering degree and experience in the administration of engineering programs.

MOLECULAR DISTILLATION. By G. Burrows. Oxford University Press, 417 Fifth Ave., New York 16, N. Y., 1960. 214 pages, 5½ by 8¼ inches, bound. $5.60. A synthesis of current knowledge on the theory and practice of molecular distillation, this monograph deals with the underlying principles, the engineering problems associated with the production and maintenance of the necessary degree of vacuum, and the special features of gas and vapor flow at low pressures. Typical degassers and molecular stills and their applications also are discussed.

NATIONAL ELECTRICAL CODE HANDBOOK. By A. L. Abbott. Tenth edition. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N. Y., 1960. 680 pages, 5½ by 8½ inches, bound. $10. The purpose of this book, sponsored by the National Fire Protection Association, (NFPA), is to elucidate the plan, scope, and intent of the National Electrical Code (NEC) (NFPA no. 70—June 1959, in Vol. 5 of "National Fire Codes—1960") by presenting supplementary reference material consistent with the NEC and with the interpretation of it issued by the NFPA. This 10th edition is completely rearranged in line with the renumbering and rearrangement of the NEC in 1959, and contains information on developments since 1957.

TECHNICAL LITERATURE

The following recently issued technical literature may be of interest to readers of *Electrical Engineering*. All inquiries should be addressed to the issuers.

BASICS OF ANALOG COMPUTERS. Provided with more than 400 illustrations, this "picture-text" volume is valuable to the practicing engineer, teacher, maintenance technician and college student. It deals with the concepts and applications of the analog computer as well as the devices and is divided into three sections: *Analog Computing Principles and Techniques; General Purpose Analog Computers; Using the D-C Analog Computer*. Available from John Rider Publisher, Inc., 116 W. 14th St., New York 11, N.Y. for $12.50 per copy.

ENGINEERING PROFESSIONALISM IN INDUSTRY. Prepared under the sponsorship of the Professional Engineers Conference Board for Industry, the objectives of this research were to find out from engineers and engineering managers how important they consider engineering professionalism to be, what they mean by it, what they consider its present status to be in companies, and what they think can be done to advance it. The survey findings are based on 350 personal interviews. The engineers all hold college or advance degrees in engineering and are employed in recognized engineering assignments. The managers include directors of industrial relations, production managers, chief or managing engineers, project engineers, etc. The report may be obtained from the National Society of Professional Engineers, 2029 K St., N. W., Washington 6, D. C. at $4 per copy for nonmembers and $2 for members.

SCIENTIFIC AND TECHNICAL PERSONNEL IN AMERICAN INDUSTRY. As reported by the National Science Foundation, employment of scientists and engineers in industry rose nearly 7% between January 1959 and January 1960. More than 800,000 scientists and engineers were employed by business firms covered by a survey; electric equipment and aircraft industries each employed around 100,000 scientists and engineers in January 1960. This report may be obtained from the National Science Foundation, 1951 Constitution Ave., N. W., Washington 25, D. C. for 45¢.

AMENDMENT NO. 1 TO IEC PUBLICATION 103 — RECOMMENDATIONS FOR ALUMINUM ELECTROLYTIC CAPACITORS FOR GENERAL PURPOSE APPLICATIONS. Published by the International Electrotechnical Commission, this publication represents an international standards recommendation on a definition of rated surge voltage and a test to determine it. Copies are available at 40¢ each from the American Standards Association, Dept. PR 192, 10 E. 40th St., New York 16, N.Y.

NUCLEAR FUEL ELEMENT DEVELOPMENT. 1960 H. W. Gillett Memorial Lecture. R. C. Dalzell, assistant to the director of the Division of Reactor Development, United States Atomic Energy Commission, presented before the 63rd Annual Meeting of the American Society for Testing Materials a lecture in which he reminded his audience that today our Navy operates nuclear-powered submarines under the polar icecap without fear of reactor failure. He also pointed out the tremendous strides made in the field as well as the many problems that still exist. Copies of the lecture may be obtained from the American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa., at $1 each.

LUNAR ATLAS SUPPLEMENT. This is the first supplement to Dr. G. P. Kuiper's Lunar Atlas, published earlier this year by the University of Chicago Press. The supplement contains 29 "closeup" photographs of the moon. It is available from the University of Arizona Press, The University of Arizona, Tucson, for $8.

INSTRUMENTATION AND HIGH-SPEED PHOTOGRAPHY. Volume I, Series II. A compilation of papers reprinted from the SMPTE Journal, this 187-page volume begins with a discussion of the design of underwater automatic and controlled cameras, includes a color-illustrated paper on submicrosecond color photography of explosive phenomena. Included in a series of papers on missile photography is a discussion of flying camera stations to obtain attitude, trajectory, and documentary data of missiles launched from aircraft at high altitudes. Other papers are devoted to light sources, optics and visibility studies, the properties and uses of cathode ray tubes, television systems in instrumentation, etc. Also included are French and German abstracts of the papers in the volume. Priced at $4, it is available from the Society of Motion Picture and Television Engineers, 55 W. 42nd St., New York 36, N.Y.

SAMA-ABMA RECOMMENDED STANDARD INSTRUMENT CONNECTIONS. This standard represents a revision of the *General Recommendations for Location of Instrument & Control Equipment Connections for Power Boilers*, originally issued in 1958. and has been developed by a joint committee of the Recorder-Controller Section of Scientific Apparatus Makers Association (SAMA) and the American Boiler Manufacturers Association (ABMA). Copies are available at $3 each from the Recorder-Controller Section, SAMA, 370 Lexington Ave., New York 17, N.Y.

STANDARD FREQUENCIES AND TIME SIGNALS FROM NBS STATIONS WWV AND WWVH. This report gives detailed descriptions of six technical services broadcast by National Bureau of Standards radio stations WWV and WWVH. The services include: standard radio frequencies, standard audio frequencies, standard time intervals, standard musical pitch, time signals, radio propagation forecasts. Other domestic and foreign standard frequency and time signal broadcasts are tabulated. Available from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. for 10¢ per copy.

CALCULATOR. This new Mathfaster Calculator simplifies difficult and frequently used mechanical calculations by condensing commonly used information into a simple, circular 7-inch-diameter unit. Eliminating the need for reference to wall charts, handbooks, and data sheets, the Mathfaster permits rapid subtraction of fractions and provides immediate access to such information as decimal equivalents of fractions, illustrated dimensions of round, flat socket, or fillister head screws and nuts; tap drills and threads per inch of NC and NF screws; decimal size of both letter and number drills; diagrammed formulas for solutions to triangles and areas or volume of basic forms such as circles, trapezoids, cones, etc. Priced at $1 with instruction booklet it is available from Pierce Mathfaster Calculator, Box 837, Arleta, Calif.

SPECTRA AND ANALYSIS. Translated from Russian, this volume by A. A. Kharkevich, should be of interest to engineers working in electronics, acoustics, ultrasonics, and related fields. The first two sections covering a large amount of material briefly, offer an advantage over the existing literature by providing a concise and yet comprehensive survey for the sophisticated reader. The third section deals with the spectra of random processes, thus documenting Soviet research that is completely original. In addition to spectral concepts as they apply to oscillations in acoustics and electronic engineering and with methods of spectral analysis, of particular interest is the material on Kotelnikov's theorem for bounded spectra, the spectra and analysis of random processes, and in connection with the latter, the statistical compression of spectra. The book may be ordered from the Consultants Bureau Enterprises, Inc., 227 W. 17th St., New York 11, N.Y. The price is $8.75.

RUSSIAN ELECTRONICS AND ELECTRICITY LITERATURE TRANSLATIONS. The Office of Technical Services has released the following publications for sale to the public: *Electronics and Cybernetics* 60-31639, August 1960, 13 pages, 50¢. *All-Union Conference on Electrical Measurement Digital Computers, No. I*, 60-11972, July 1960, 10 pages, 50¢; *On a New Method of Solving Electrostatic Problems and Editorial Comments* 60-21766, May 1960, 7 pages, 50¢; *Relation of Paramagnetic Absorption to Susceptibility* 60-21769, May 1960, 6 pages, 50¢; *Measurement of Attenuation of Distributor Feeder Lines for Wire Broadcasting by the Signal Accumulation Method* 60-31353, July 1960, 9 pages, 50¢; *New Direct Fototelegraph Equipment* 60-31351, July 1960, 9 pages, 50¢; *Remote Control of a Short-Wave Transmitter* 60-31352, July 1960, 11 pages, 50¢; *The Use of Silica Gel in Cable Work* 60-31354, July 1960, 5 pages, 50¢; *A Video Tape Recorder* 60-41203, August 1960, 9 pages, 50¢. These reports may be ordered from the Office of Technical Services, United States Department of Commerce, Washington 25, D. C.

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Industrial Notes...

GATC
Chicago, Ill. . .

A thin film of nickel—so tiny it can be seen only with the aid of a microscope—is helping guide the Polaris missile to its target. The coating is Kanigen, a nickel-phosphorous alloy deposited on metals by chemical action, and produced by General American Transportation Corp. The film of nickel used on parts the size of a thumb-nail is within 20 to 30 millionths of final dimensions. The coating provides the parts with a tough armor against wear, with the additional advantage that Kanigen itself is not magnetic.

CERN
Geneva 23, Switzerland . . .

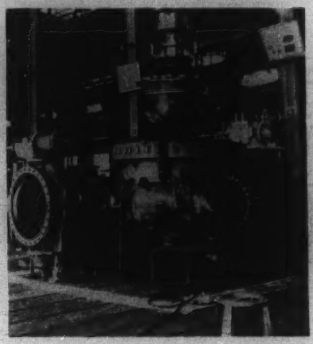
Spain last month became the fourteenth State of CERN, the European Organization for Nuclear Research. Accession of Spain was unanimously decided by delegates of the 13 actual Member States of CERN: Austria, Belgium, Denmark, France, the German Federal Republic, Greece, Italy, the Netherlands, Norway, Sweden, Switzerland, the United Kingdom, and Yugoslavia. The delegates were gathered in Meyrin for the eighteenth session of CERN's council.

Perkin-Elmer Corp.
Norwalk, Conn. . .

A gantry furnace at Commercial Steel Treating Corp., Detroit, Mich., has recently been equipped with a chromatographic instrument that automatically analyzes and controls the atmospheres inside the metal treating furnace. Called the Furnace Analyzer, the instrument is manufactured by Perkin-Elmer Corp. The installation allegedly enables operators of the 40-foot-high gantry furnace to achieve exceptional results in plain heat treating, carbon restoration, carburizing, and similar processes. In recent carburizing loads, they have consistently held results to within 0.02% to 0.04% of the desired carbon percentage.

Tokyo Shibaura
Tokyo, Japan . . .

The Tokyo Shibaura Electric Company (Toshiba) has completed construction of a reverse-current turbine for hydroelectric power generation. It has been installed at the Nagoro Power Plant of the Shikoku Electric Power Company, together with a Toshiba-made pole change generator that will be connected with the reverse-current turbine. The reverse-current turbine has been designed to operate at maximum efficiency through every fluctuation of the flow resulting from changes in the effective head. The accompanying pole change generator is also designed to operate at maximum efficiency at any volume of water-flow.



Servo Corp.
Hicksville, N. Y. . .

A patent covering automatic alarm hot box detection devices has been issued to Servo Corporation of America. The railroad safety device is known commercially as Servolarm equipment. The Servosafe Hot Box Detective is an infrared system for detecting overheated journal bearings, or "hot boxes," on passing trains. More than 200 Detective systems are currently in operation on 28 major Class I American railroads, as well as railroads overseas.

Hazeltine Corp.
Little Neck, N. Y. . .

The IFF airborne transponder, the AN/APX-46 (V), developed and produced solely by Hazeltine Corporation, has been selected by West Germany for its Lockheed F-104 all-weather fighter bomber. An airborne transponder automatically responds to electronic interrogation from land, sea, or air for identification purposes. Approved by the U. S. Department of State, this multimillion dollar Hazeltine program will be paid for in dollars in keeping with the Government's policy of reversing the gold and dollar flow abroad. Now being produced for the Canadian and U. S. Governments, the *APX-46* is a transistorized transponder which provides greatly increased reliability and is capable of operating at high altitudes under extreme temperature conditions. Modular construction permits the equipment to be adapted to the configuration of the space available in various types of aircraft.

Clark Bros. Co.
Calgary, Alberta . . .

Three gas turbine-centrifugal compressor sets have been delivered by Clark Bros. to Trans-Canada Pipe Lines Limited to power three new compressor stations in the latter's multimillion dollar expansion program to export natural gas to the United States. The turbines are Clark model *305* regenerative cycle, two shaft machines rated at 8370 hp each. They will drive 30- by 30-inch single-stage centrifugal pipeline compressors which will pump approximately 700 million cubic feet of gas per day through the world's longest natural gas pipeline. The compressors have been equipped with specially designed control systems that will be easily adapted to fully automatic, completely unattended station operation.

(*Continued on page 33A*)

Industrial Notes

(Continued from page 30A)

Globe Industries Dayton, Ohio . . .

Globe Industries, Inc. has placed in operation a "white room" for assembly of critical electric motors and other devices. The privately-built facility is part of an overall reliability program established at the company to provide customers with products whose reliability levels must be rigidly specified. Access to the sealed room is through an

air lock. Inside, the temperature, humidity, and air purity are held constant. Temperature is 76 C; relative humidity is 40 to 50%; all incoming air passes through an electronic precipitator, as well as the air conditioner and dehumidifier. The skilled workers assigned to the facility wear lintless smocks, hair coverings, and special moccasins to guard against the entry of dust and dirt.

Gulton Industries Metuchen, N. J. . .

Gulton Industries, Inc., has formed Gulton Industries (Israel) Ltd. with headquarters in Tel Aviv, for the manufacture of basic electronic products for both local and export markets. Gulton Industries will share equal ownership of the Israeli firm with the Swiss Israel Trade Bank. The formation of the new company was carried out with the support of the Government of Israel. Negotiations are being concluded for a plant site in Jerusalem where production is expected to begin within 6 months. Temporary headquarters for the new company are in care of the Foreign Trade Bank, 39 Rothschild Boulevard, Tel Aviv. The electronic products to be initially produced in Jerusalem will be based on research and development work done in the United States by Gulton. The Israeli company will also have its own research and development staff.

(Continued on page 34A)

FLUCTUATING

LINE VOLTAGES giving you trouble?

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100 kva Line Voltage Compensator installed at radar station operates on 3-phase input of 208v ±10%, delivers 208v ±1% at 300 amps, with no sine wave distortion.

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Industrial Notes

(Continued from page 33A)

RCA
New York, N. Y. . .

Radio Corporation of America has developed an RCA Bi-Directional Distribution System which makes it possible to send television signals in two directions simultaneously over the same cable arrangement. Designed for educational television, the development permits closed-circuit material to be introduced into the system from any classroom, while allowing reception of off-the-air television signals. Thus, one part of a school can receive closed-circuit programming at the same time that another part is receiving off-the-air telecasts.

EASA
St. Louis, Mo. . .

Six electronic motor control courses for employees of independent electrical apparatus service firms in North America will be held in major cities in March, April, and May by the Electrical Apparatus Service Association, Inc. The 5-day courses will be held in Philadelphia, Pa., March 6-10; Boston, Mass., March 20-24; Atlanta, Ga., April 3-7; Oklahoma City, Okla., April 17-21; Los Angeles, Calif., May 1-5; and Minneapolis, Minn., May 15-19. Each course will be directed by G. D. Long, instructor of maintenance schools, Reliance Electric & Engineering Co., Cleveland, Ohio. The program will begin with lectures and discussions on basic electricity and electronics, and range through control of motor generator fields, variable speed control, internal circuitry, trouble shooting methods, magnetic amplifiers, and other related topics. Courses will be limited to 50 persons each on a "first-come, first-served" basis. An enrollment fee of $65 covers text and laboratory materials, equipment rental, and overhead. Applications should be sent to Mr. Baechle at EASA headquarters, 7730 Carondelet Ave., St. Louis 5, Mo.

Electronic Industries
Washington, D. C. . .

A move which would have the effect of making obsolete most existing television sets has been proposed by Federal Communications Commissioner R. E. Lee as a means of making transmission channels available for some 200 stations now kept off the air for lack of broadcast frequencies. Specifically, the plan advocates shifting all television transmission into ultra-high-frequency (uhf) bands within 5 to 7 years, or approximately the life of television receiving sets. Most television transmission now is at very high frequency (vhf) and only about 6% of the approximately 60 million television sets now in use can receive uhf signals. Mr. Lee said that there is a "good chance" Congress will pass FCC-sponsored legislation which would have the effect of requiring television manufacturers to produce only sets capable of receiving both uhf and vhf signals. He admitted the proposal runs counter to his opposition to government interference with private enterprise, but contended the legislation to be justified in view of the "critical nature of the present situation." The 12 channels now being used by television, he said, could be assigned, following the shift to UHF, to mobile radio communications services now badly needed by industry, police, fire, forestry, educational institutions, and private and public agencies.

Boulder Laboratories
Boulder, Col. . .

A more efficient measurement technique for calibrating attenuators over a wider frequency range has been developed in the National Bureau of Standards' Radio Standards Laboratory at Boulder, Col. The new technique will result in extending the accurate service previously available at 30 mc to include similar calibration service at 1, 10, 60, 100, and 300 mc. Calibrating instruments, including two highly accurate piston attenuators, are being incorporated into a large console that will enable one man to perform attenuation measurements in a matter of minutes, Previously it has taken several people hours or days to perform the same task.

AiResearch Mfg.
Phoenix, Ariz. . .

Flight testing of a new AiResearch ground support pod being delivered to the U.S. Navy has been successfully completed. Aerodynamic design of the torpedo-shaped 22-foot-long small gas turbine powered unit, designed for transport as external aircraft stores, was proved and exceeded in the flights. Testing for the pod included level flight at varying altitudes to 40,000 feet, stalls, and 3- to 5-g rolls and pull ups. Speeds through Mach 1 found only two narrow subsonic buffet zones, which presented no aircraft handling difficulties. Flights above Mach. 0.96 were reported entirely smooth. The complete ground power package provides refrigeration, pressurization, starting, electric power for Navy aircraft.

Air Reduction
New York, N.Y. . .

Air Reduction Sales Company has taken advantage of a new packaging idea which minimizes the absorption of moisture in low hydrogen type electrodes in introducing its Barrier Carton. The packaging insures freshness and dryness of the electrodes to be used in applications where close control of moisture content must be achieved in the Barrier Cartons by an inner layer of aluminum foil in the corrugated cardboard. In using the new containers, Airco hopes to eliminate the very damaging problem of excess moisture in electrodes picked up in transit and storage.

International Rectifier
El Segundo, Calif. . .

Solar cells which power the National Aeronautics and Space Administration's new weather satellite Tiros II are wearing "sun glasses" to protect them from the intense heat rays of the sun in space. A total of 9,260 individual silicon solar cells were supplied by International Rectifier Corp. to the Radio Corporation of America's Astro-Electronics Division of the Tiros II solar power system. Each of the cells is optically treated to aid the emittance of the sun's rays in the long wave, or heat region. This enables the silicon cells to operate more effectively in the photovoltaic conversion of sunlight into electric energy. Because solar cells are actuated by sunlight, solar heat impedes photovoltaic action of their electrons. The optical treatment, which scientists describe as similar to putting sun glasses on each individual cell, also protects the surface of the silicon from any meteorite dust showers the Tiros II may encounter in orbit. With the extra protection, the life of the solar cells is prolonged indefinitely, since as solid-state semiconductor devices they cannot wear out through the inner activity of their electrons.

(Continued on page 37A)

Industrial Notes

(Continued from page 34A)

Minneapolis-Honeywell
New York, N. Y. . .

A Honeywell *800* system, a product of the Electronic Data Processing Division of Minneapolis-Honeywell Regulator Co., is shown in a demonstration of its high-speed data processing prowess at the company's headquarters in Boston, Mass. Girl at the operator's console in the background

can monitor the progress of up to 8 independent jobs being handled simultaneously. She is flanked on her right by a bank of magnetic tape units which read or record information at the rate of 96,000 decimal digits (numerals) per second. At her left is the central processor or computing unit of the system which performs at rates as high as 40,000 additions per second. Male operator in the foreground is observing the output of the system's high-speed printer as it automatically types out copy at the rate of 900 lines per minute.

Atomics International
Canoga Park, Calif. . .

A prototype of the first nuclear reactor for outer space has been developed by Atomics International, a division of North American Aviation, Inc., as part of the Atomic Energy Commission's Systems for Nuclear Auxiliary Power (SNAP) program. The 1-year test program, just completed successfully, has verified significant performance characteristics necessary to design the final flight reactor. The lightweight, high-temperature test reactor is about the size of a 5-gallon can. It weighs approximately 250 pounds and is fueled with enriched uranium. It is a prototype reactor for the SNAP 2, 8, and 10 systems which will generate auxiliary electric power in the kilowatt range continuously for a year. Flight demonstration of SNAP 10 is expected in 1962 or 1963.

Tracerlab
Waltham, Mass. . .

Tracerlab, Inc., has received an order from the Brazilian Government for medical radioisotope instrumentation for the capitol city's new medical center. Tracerlab will equip the new facility with medical research and diagnostic equipment for the utilization of radioisotope "tracer techniques." Instrumentation for the ultra-modern medical facility will include electronic isotope apparatus for automatic analysis of medical and biological specimens, and an isotope scanning system which allows doctors to locate positively, accurately, and quickly, tumors or malfunctioning organs without resorting to exploratory surgery or costly, complicated diagnostic techniques. Tracerlab's most recent development, a system for the analysis of coronary blood flow, will be part of the equipment to be supplied.

F. J. Stokes Corp.
Philadelphia, Pa. . .

The manufacturer believes that better dielectric properties and greater dependability of the stator assemblies for electric generators will result from more complete and thorough penetration of the epoxy and phenolic resins with which the stator assemblies are impregnated in this new stokes system. Chief feature of the system is the quick-opening and quick-closing cover on the impregnating chamber (at right in photograph). The cover is sealed shut by means of a new split-ring type

of closure that has only one locking point, at the front of the unit, and can be clamped shut or wrenched open in less than 1 minute manually, as shown. The system, including all interconnecting piping and valves, and electric wiring, is built together on a common base-plate 7 by 5 feet, so that the equipment is ready to go to work immediately upon delivery.

(Continued on page 38A)

AiResearch Gyro Conditioners for the U.S. Army Sergeant missile are the most complete and efficient systems of their type.

The 8 lb. package, consisting of heat exchanger, heater, thermal switches and three fans, maintains a hermetic atmosphere of 85°F. to 160°F. in an outside ambient temperature of —20°F. to 140°F. Even temperature levels throughout the electronic compartment are maintained by an internal fan and low velocity air movement.

AiResearch is the leading designer of such advanced electronic conditioning equipment and systems, and this production unit is but one example of many produced for missile and ground support applications.

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AiResearch Manufacturing Division

Los Angeles 45, California

Industrial Notes

(Continued from page 37A)

Delco Radio
Kokomo, Ind. . .

Improved manufacturing techniques at the Delco Radio Division of General Motors Corp. have permitted the division to cut in half the diode leakage current at maximum rated voltages on its higher quality transistors. This pertains to the entire *TO-36* line of transistors rated at 50 volts and higher. Specifically, the diode leakage currents at the maximum rated voltages have been reduced from 8 ma to 4 ma. This is almost four times lower than the maximum specified in the 2N174 JAN specification. The achieved reduction in diode currents has been attributed to a quality improvement program stressing improved surface cleanliness.

Raytheon
Waltham, Mass. . .

"Cook-it-yourself" electronic cafeterias which use neither kitchens nor steam tables now provide hot meals of the diner's choice in just 60 seconds. Meals are prepared by an outside commissary, frozen, served refrigerated, and reheated by the cafeteria patrons in 60 seconds in Radarange microwave ovens. Pre-cooked meals are selected from a refrigerated display case. The meals are on plasticized, disposable tray-dishes and come sealed in transparent envelopes with color-coded tape. The patron places the dinner of his choice into one of the Radarange ovens

equipped with automatic timers with color-coded buttons to match the dinners. The timers control the amount of microwave energy used to heat the meal, with the average time being about 60 seconds. The new cafeterias save space and relieve sanitation problems, as well as whittle down costs.

Collins Radio
Dallas, Texas . . .

Collins Radio Company began construction last month of an $18 million manufacturing building on its 200-acre site at Richardson, Texas. The new building will contain 117,000 square feet of floor space and will be built of steel and reinforced concrete with exterior walls of contoured concrete panels. The building, scheduled for completion in August of this year, will house manufacturing and assembly functions with supporting office space and cafeteria. The 1-story structure will be the second major building on the site.

INCO
New York, N.Y. . .

A new technical service which will deal with nickel alloys at elevated temperatures has been established in the Development and Research Division of the International Nickel Company, Inc. The new High Temperature Engineering Section will serve industry on all problems arising in the use of materials in environments at elevated temperatures. The section will develop and disseminate technical information in the field of high temperatures, and will also be prepared to give advice on the selection of appropriate materials for high-temperature applications.

International Rectifier
El Segundo, Calif. . .

International Rectifier Corporation, semiconductor manufacturers, and Piemontese Sviluppo Industriale, S.P.A. (Piedmont Industrial Development Company), one of Italy's largest industrial holding companies, have combined forces to launch a projected multi-million-dollar semiconductor manufacturing facility on the European continent. The company's Italian subsidiary, International Rectifier Corporation Italiana, S.P.A., has become the corporate structure for the joint venture. A complete range of semiconductor rectifiers and automotive diodes will be produced in Italy to supply industry in the European common market. A new 16,000-square-foot air-conditioned building on a 2-acre site in Borgaro, Italy, near Turin, will house the initial production facilities, started in December 1960. Production is scheduled to begin in April 1961, with a full production rate to be achieved by the summer of 1961. Additional buildings will be erected on the site at a future date.

Shockley Transistor
Palo Alto, Calif. . .

Shockley Transistor will erect a new building, the first of four planned for Palo Alto center. The facility will consolidate the administration, research, production, and marketing operations that have grown into three separate buildings in Palo Alto and

near-by Mountain View. The first unit will be a $1 million building located on the company's 10-acre site, and scheduled for completion in the spring of 1961.

Litton Industries
Beverly Hills, Calif. . .

Westrex Corporation, a division of Litton Industries, has established a Geophysical and Oceanographic Instrumentation Laboratory at its New York City headquarters. The laboratory's activities will include expansion of the company's present line of precision depth recorders, time and frequency standards, contour temperature recorders, and the development of data recording techniques and systems for geophysical and industrial applications.

Academy of Sciences
New York 21, N. Y. . .

A method of protecting men against carbon-dioxide poisoning in nuclear submarines, space craft, or other confined quarters was described at a recent New York Academy of Sciences conference on amine buffers. In nuclear-powered submarines carbon-dioxide may rise beyond the safe level, thus necessitating the development of techniques to "scrub" it from the atmosphere. Amines—chemicals resembling the ammonium molecule—are used to achieve this end. One of these, monoethanol amine, is described as a self-regenerating carbon-dioxide scrubbing agent, which absorbs carbon dioxide when cooled, and releases it when heated under pressure. The gas thus removed from the submarine atmosphere can be released overboard into the water.

AIEE SPECIAL PUBLICATIONS

To meet a specialized need, or where it has become advantageous to collate a number of papers on a subject in one pamphlet, a series of special publications has been established. Prices quoted are (M) for AIEE members, and (N) for nonmembers.

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S74	AIEE Electric Heating Conference (4/55)	2.50	2.50
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S104	Application of Incremental Heat Rates for Economic Dispatch of Power (7/58)	3.00	3.00
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S25	Elements of Nucleonics for Engineers (3/49)	.60	1.20
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S37	Lightning Reference Bibliography (4/50)	.35	.70
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T125	Materials Handling Conference (10/60)	4.00	4.00
S28	Mathematics for Engineers	.15	.30
T123	National Electronics Conference (10/60)	3.00	3.00
S65	National Telemetering Conference, 1954	2.00	2.00
T115	1959 National Telemetering Conference (5/59)	6.50	6.50
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T93	Rectifiers in Industry (5/57)	4.00	4.00
S53	Review of Input and Output Equipment Used in Computing Systems (3/53)	4.00	4.00
S108	Safety in Industrial Power Distribution Systems (12/58)	1.00	1.00
S109	Second Report on Survey of Electric Utility Applications of Digital Computers (12/58)	1.50	1.50
S109A	Third Report on Survey of Electric Utility Applications of Digital Computers (12/60)	2.50	2.50
S95	Second Symposium on Polyethylene Wire and Cable Insulation (10/58)	1.00	1.00
S42	Sources of Electrical Energy (1/51)	.75	1.50
S120	Soviet Computer Technology, 1959 (8/60)	1.00	1.00
S36	Symposium on Electrical Properties of Semiconductors and the Transistor (1/50)	.25	.50
S66	Symposium on Higher Distribution Voltage for Metropolitan Area (9/54)	2.00	2.00
S56	Symposium on the Use of Aluminum for Insulated Conductors (11/53)	1.50	1.50
S12	Telemetering, Supervisory Control, and Associated Circuits (9/48)	1.00	2.00
S111	Telemetering, Supervisory Systems, and Associated Channels (6/59)	2.50	2.50
S81	Thermal Evaluation of Insulating Materials (6/54)	1.50	1.50
S63	The Second Feedback Control Systems Conference (4/54)	3.50	3.50
T113	Third National Conference on Analog and Digital Instrumentation (3/59)	5.00	5.00
S5	Ultrashort Electromagnetic Waves	.50	.50

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Trade Literature . . .

Hardware History . . .

A 32-page booklet, "The History of Hi-Line Hardware" illustrates progress in this line since its beginnings in 1882. Profusely illustrated in two colors, the booklet is available from *The Brewer-Titchener Corp., Cortland, N.Y.*

Gold Alloy Preforms . . .

Technical bulletin Z-108 describes gold alloy preforms for use in semiconductor processing. The bulletin offers information on the use of gold alloy preforms for two applications: as a joining material to produce an ohmic junction, and when doped with n or p type elements, as an alloy junction material. Listed are melting point range of the gold alloys, typical alloys for various applications, and sizes and tolerances of the preforms which are available as spheres, discs, and washers, as well as special sized stampings. *Accurate Specialties Co., Inc., 345 Lodi St., Hackensack, N.J.*

Mesa Transistors . . .

A 4-page application note, "The *2N741* Mesa Transistor as a Power Oscillator and Class C Amplifier," describes these circuits using low-cost *2N741* mesa transistors. The note includes circuit schematics and performance curves. Seven illustrations supplement the text as aids to the circuit designer. *Technical Information Center, Motorola Semiconductor Products Inc., 5005 E. McDowell Rd., Phoenix, Ariz.*

Transfer Nameplates . . .

"Directory to Quality Transfer Nameplates" has been issued to assist purchasing agents, engineers, and designers in specifying and purchasing the correct types of decal transfers for specialized applications. Because marking problems vary in specific situations, rapid application of transfers is needed in some cases, high resistance to abrasion, solvents, or weathering in others. This directory explains the differences between these types of decal transfers. Types of in-stock transfers are covered and newly developed nameplates for dry "pressure-sensitive" application are detailed. *The Meyercord Co., 5323 West Lake St., Chicago 44, Ill.*

Power Supply Modules . . .

An 18-page brochure explains the dangerous troubles that originate from faulty and poorly regulated d-c power supplies, describing stray and false information, false triggering of circuits, harmful changes in pulse shapes, distortion of in-put signals by ripple, and high transient destruction of transistors. Called "The Inside Story of the New Plug-In Power Supply Modules," the brochure gives a detailed and graphic account of the design achievements attained in the latest miniature plug-in modules, and their prevention of malfunction of associated apparatus. Each specification of the new modules is defined and explained in detail. Examples make clear the dangers inherent in inferior specifications and the safety factors provided by the new advanced specifications. Uses and advantages of such special features as remote error sensing and remote programming are described. *Valor Instruments, Inc., 13214 Crenshaw Blvd., Gardena, Calif.*

Membrane Filters . . .

A 3-page manual, "Radiochemical Applications of the Membrane Filter," gives information on techniques useful in radiochemical application. Twenty-five references are included. Request Manual No. 5 from *Gelman Instrument Co., 106 N. Main St., Chelsea, Mich.*

Nuclear X Rays . . .

This 4-page folder titled "Nuclear Problems Handled with X-rays" was reprinted from a national engineering magazine and is illustrated with photos and a calibration curve. Text discusses analytical procedure for uranium fuel alloy ingots; stainless steels, including 18-8 and columbium-stabilized types; silver-gold previous alloys; uranium dioxide stainless steel powder blend; and hafnium reactor control rods. The folder describes how synthetic standards are prepared and used in daily operating routines. Isotopic corrections are explained together with method of applying correction factors, and techniques and equipment functions are covered. The booklet cites actual test examples and gives X-ray accuracies for different sample materials. Applications of the analysis method to various fuel element alloys are discussed in detail. *Philips Electronic Instruments, 750 S. Fulton Ave., Mt. Vernon, N.Y.*

For Consulting Engineers . . .

A 24-page booklet, "Preparation of a Consulting Engineer's Firm Brochure," published by the Consulting Engineers Council, is available to member firms, as a "blueprint" to follow in compiling individual firm brochures. Included are excerpts and ideas compiled from actual published brochures of a number of consulting engineering firms throughout the country. The purpose of the booklet is to acquaint consulting engineers with the possibilities of this facet of public relations. *Consulting Engineers Council, 326 Reisch Bldg., Springfield, Ill.*

Mercury Vapor Lamp Manual . . .

This 28-page technical booklet contains the latest information on nearly all phases of mercury lamps including light output, life ratings, and electrical and physical characteristics. In addition, it describes lamp construction, designations, color rendition, and necessary auxiliary equipment. The manual discloses increases in initial light output of a number of mercury lamps, and contains a section on applications of the lamps. Covered in the booklet are industrial lighting, street and floodlighting, and lighting of public buildings. Information on mercury vapor lamp luminaires is included. Available from local lamp sales offices of *Westinghouse Electric Corp.*

Microwave Measurements . . .

A 100-page application note presenting basic information on microwave measurements is available in booklet form. Entitled "Introduction to Microwave Measurements," it is said to be particularly useful to colleges and universities, and to industrial and government groups who must regularly introduce new technical personnel into the field of microwave measurements. The fully illustrated booklet presents general background information on microwaves, discusses microwave transmission theory, and describes basic microwave measurements and the equipment used in making these measurements. It also presents eight basic experiments designed to help the student or microwave novice become acquainted with measurement techniques. Appendix material includes a glossary of microwave terms and data sheets on various microwave measuring equipment. "Introduction to Microwave Measurements" (Application Note no. 46) may be obtained by writing *H. J. Lewenstein, Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif.*

Silicon Rectifiers . . .

An 8-page illustrated booklet on silicon rectifiers includes a comprehensive selection guide. Listing more than 400 different rectifiers, the booklet SG-1351 contains complete circuit constant charts for power supply design, a special section on high-voltage silicon rectifiers, rectifier circuit design application notes, and rectifier cell outline drawings. *Transitron Electronic Corp., Wakefield, Mass.*

Photometry Applications . . .

The terms, symbols, and units used in photometry are defined in this bulletin, and their relationship to corresponding radiometric terms is given. In addition, the pamphlet presents methods for the calculation of tube-face illumination for camera tubes, and screen luminance for cathode-ray tubes. Copies of Application Note *AN-187* may be obtained from *Commercial Engineering, Electron Tube Div., Harrison, N.J.*

Conversion Guide . . .

A 16-page static power conversion guide is an explanation of the field of controlled electric power. The booklet outlines the advantages of static power equipment, and provides useful comparisons between static and rotating electrical devices. *Sales Manager, Hamilton Standard, Broad Brook, Conn.*

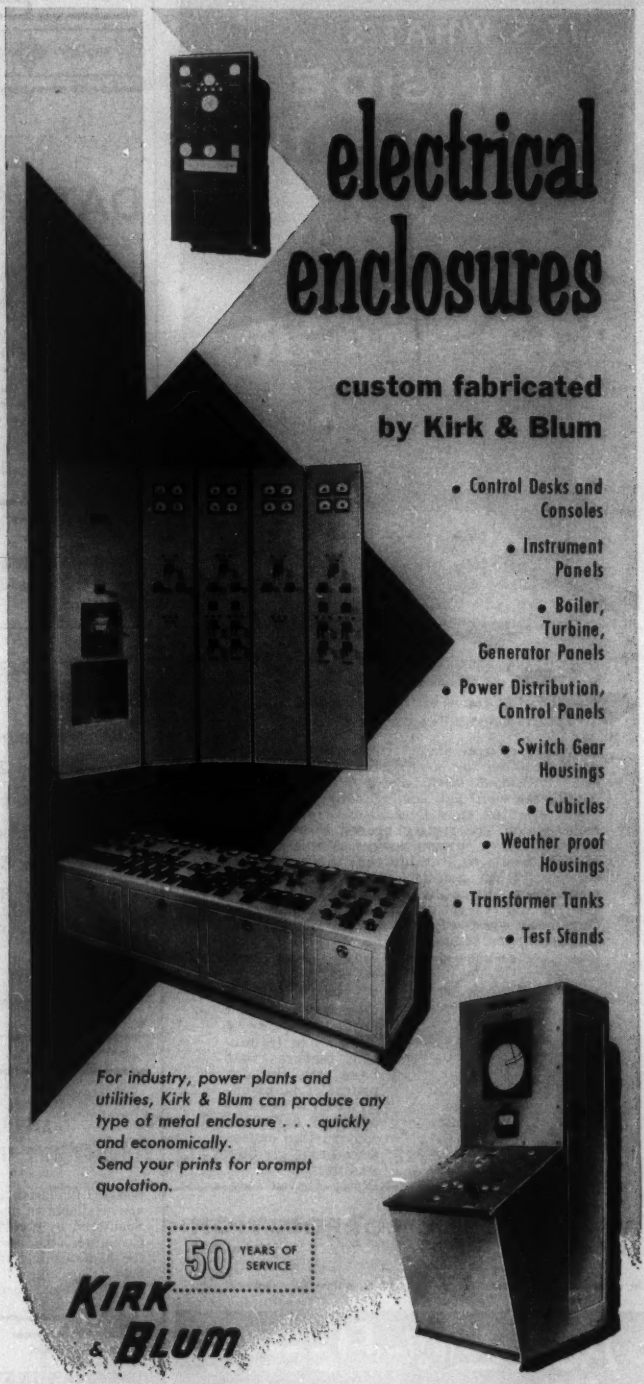
Electrostatic Precipitators . . .

Copies of a recent talk on electrostatic precipitators by L. L. Nagel are available upon request. The paper discusses what the plant engineer should know about the requirements of an electrostatic precipitator for industrial applications. *Buell Engineering Co., 123 William St., New York 38, N.Y.*

Adhesives List . . .

This 2-page leaflet gives a brief explanation of the place of adhesives in modern manufacturing and engineering design, and lists typical products and their specific applications. Included is a listing of industries which use adhesives regularly, and an outline of how the manufacturer can help suggest the most suitable adhesive for a given job. *Mr. Louis Leaman, Magic Chemical Co., 121 Crescent St., Brockton, Mass.*

(Continued on page 43A)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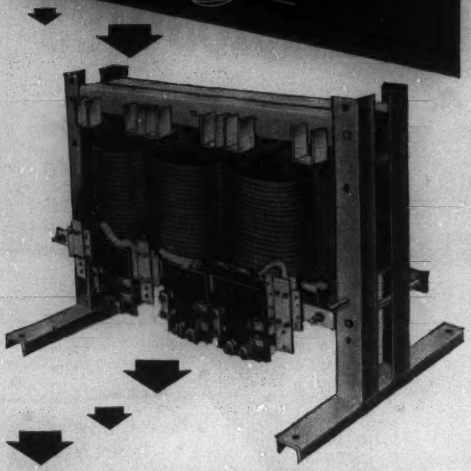

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Trade Literature

(Continued from page 41A)

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The newest bulletin in the "Tech Tips" series describes high-vacuum as well as gas phototubes, photomultiplier tubes, photocells, and photoresistive cells. Typical applications are shown for photoresistive cells combined with transistors. The effects of temperature, excessive illumination, and other environmental conditions are described. Written by Robert Tomer, author of "Getting the Most Out of Vacuum Tubes," bulletin PA-220 describes test methods and gives various suggestions for servicing equipment using photosensitive devices. Available through distributors of CBS tubes and semiconductors, or from *CBS Electronics, Information Services, 100 Endicott St., Danvers, Mass.*

"New Design Ideas"

Published at 2-week intervals, each of these papers analyzes a specific design problem and its proven solution with 4-layer circuitry. In most cases, this simple circuitry uses far fewer components than do conventional transistor techniques. Covering a wide range of circuit functions, the series discusses many new application areas for p-n-p-n devices. Actual design case histories form a background for much of the material covered. To receive the series at no charge, write *Dept. AN, Solid State Products, Inc., 1 Pingree St., Salem, Mass.*

Rectifier Line Catalog . . .

A new illustrated catalog describes the manufacturer's complete line of certified silicon and selenium rectifiers. Illustrated in color, the 8-page Condensed Catalog no. 100 includes cutaway drawings revealing construction features of silicon diodes and stacks, and selenium rectifiers, stacks, and cartridge rectifiers. Included is a full list of more than 350 JEDEC types of silicon rectifiers available. Complete electrical and mechanical specifications are listed in individual tables devoted to each product line. Typical operating characteristics of both silicon and selenium rectifiers also are shown in curves displaying forward current rating levels and derating curves for raised ambient temperatures. *Semiconductor Division, Syntron Co., Homer City, Pa.*

(Continued on page 44A)

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Trade Literature

(Continued from page 43A)

Hydraulic System Reprint . . .

A technical reprint showing schematics, details, and applications on their 6-channel hydraulic force control system is offered by this company. Used for static and dynamic loading test stands, the system is designed for up to 100,000 pounds force capacity per cylinder, and includes a load cell in series with each cylinder to provide the force feedback component to the console. Request bulletin TD-104 from *Gilmore Industries, Inc., 13015 Woodland Ave., Cleveland 20, Ohio.*

Electron Beam Welding Unit . . .

Reprints are now available of an article by W. J. Greene, R. R. Banks, and R. M. Niedzielski, titled "A New Electron Beam Welding Unit." Delivered as a paper before the American Welding Society convention in Los Angeles, Calif., April 1960, the article appeared in the August issue of the *Welding Journal.* Complete with graphs and illustrations, the article provides complete background information on the process. Following a general discussion of the apparatus, the three basic elements of the electron beam welder—electron-optics system, power supplies, and vacuum system—are detailed. A final section reviews the electron beam welder's welding characteristics. Request form ADR 128 from *Air Reduction Sales Co., a division of Air Reduction Company, Inc., 150 E. 42nd Street, New York 17, N.Y.*

"Precious Metal Electrical Contacts" . . .

A detailed study of precious metal electrical contacts, their applications and selection criteria, is included in this technical bulletin, together with other articles on thermocouple materials, problems posed by radioactivity in the refining of precious metal scrap, a review of a technical film on refining precious metals, and abstracts of recently issued U. S. patents concerning precious metals. Authored by Dr. C. S. Barker, the bulletin divides into three main areas the many factors requiring consideration in the selection of the material for any particular contact application. Typical considerations are exemplified. Five tabulations of typical electrical contact materials indicate alloy compositions, and list specific applications in which the particular alloys have been successful. The effects of particular alloying additions are discussed, as are the basic differences between wrought and sintered products in relation to their performance as electrical contacts. Two articles on thermocouple materials are included. Copies of the quarterly publication may be obtained from the *Technical Information Dept., Engelhard Industries, Inc., 75 Austin St., Newark 2, N.J.*

Truck Selection Manual . . .

"Proper Truck Selection" is the subject of an 8-page, 2-color brochure designed for materials handling engineers. Listed are five ways in which a misapplied truck can damage cost position. Case histories show how installation of the wrong truck may result in unproductive output and increased costs. Correct solution, plus five pages of application photographs illustrates the importance of truck selection. Seven tips for choosing the right truck to fit each application are also listed. *Automatic Transportation Co., 149 W. 87th St., Chicago, Ill.*

Measurement Bulletin . . .

Issue no. 3 of "Design Ideas," quarterly technical bulletin, presents the second part of the previous issue's discussion of 3- and 4-terminal precision resistance measurement techniques. The 4-page 2-color bulletin describes in detail the latest techniques and equipment for calibrating a resistor of any value with predictable accuracy relative to a single certified resistance standard. *Electro Scientific Industries (formerly Electro Measurements), 7524 S. W. Macadam Ave., Portland 19, Ore.*

Plastics Welding . . .

A 4-page manual contains operating and maintenance instructions for welding thermoplastics such as polyethylene, polypropylene, rigid and plasticized PVC, and plasticized tank linings. Manual 60-2 includes general description, installation procedure, operating instruction (preparation of material, tacking operation, hand-welding, medium, and high-speed welding with round rod and plasticized strip), warranty, and application drawings. For manual 60-2, write to *S. J. Kaminsky, Kamlar Products Co., 932R Washington St., Norwood, Mass.*

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Read this compilation of papers presented at the Eighth Annual Engineering Management Conference

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